THURSDAY, APRIL 11, 1878

THE APPLICATION OF ELECTRICITY TO RAILWAY WORKING

The Application of Electricity to Railway Working. By William Edward Langdon, Member of the Society of Telegraph Engineers; Superintendent (Engineering Department) Post-Office Telegraphs; and late Superintendent of Telegraphs on the London and South-Western Railway. (London: Macmillan and Co., 1877.)

IF any proof were needed of the vast and important services that science has conferred upon man, no more eloquent example could be instanced than that great combination of the conceptions of Stephenson and of Volta—the locomotive and the voltaic battery—which combination in its elaborated form is known as the railway system of the present time.

Living as we do in the midst of conveniences of transit, the mere belief in the possibility of which would, fifty years ago, have made a man a fit inmate for a lunatic asylum, we are apt to lose sight of the complexity of the problem that has been solved and to forget the all-important part which science has played in rendering such a state of things not only possible, but an accomplished fact of so familiar a nature as to have become a necessary part of our very existence. But when it is remembered that upon most of the lines of railway in and around London several hundred trains are running daily[1] at intervals varying from three minutes to half an hour, that each of those trains requires a separate series of signals only to protect it from collision, and that interspersed with the regular traffic "specials," "light engines," and trains out of time have to be provided for and protected against (to say nothing of the goods traffic, or of shunting, crossing and junction operations), it will be readily understood that traffic management, holding in its hands the power of life and death, is no easy task; and that without some very elaborate combination of sound administrative organisation with scientific instrumental aid, the traffic of a single hour would soon become an inextricable tangle of confusion.

Notwithstanding the great importance of the subject, involving as it does the safety of millions of human lives, it is somewhat surprising that technical literature should hitherto have been devoid of a work upon the very essence of safety in railway working—the application of the electric telegraph and of electric signalling to traffic management. This need has now been very ably supplied by the work before us, every page of which bears upon its face the evidence of being written by a thoroughly practical master of the subject in all its details and ramifications, and at the same time by one who possesses an exceptional power of making the subject clear to his readers.

In a handbook of a particular application of electricity it is refreshing to find that no valuable space is occupied by matter to be found in every elementary text-book of physics, that neither Thales with his amber nor Galvani with his frogs are even mentioned, and that descriptions of the various forms of the voltaic battery find no place in the book. The author presupposes that the necessary elementary knowledge is possessed or can be obtained by his readers, and disposing in one page of a few necessary introductory definitions plunges at once into his subject.

The work is arranged in three principal divisions:—(1) Speaking telegraphs; (2) Block signalling; and (3) Miscellaneous appliances. Under the first division a chapter is devoted to descriptions of the various speaking instruments and of the methods by which they are worked. The second chapter treats of signalling regulations, and while being of special value to all professionally engaged in railway working must prove most instructive and interesting to outsiders, who are thereby let into some of the technical mysteries of telegraphy. Every one is familiar with blank spaces left at the head of the telegraph forms issued by the Post Office, against which are printed the words "Prefix," "Code time," "Words," &c., but comparatively few know their meaning. The *Prefix* to a telegram is a signal letter or abbreviation to indicate the character of the message which follows, and therefore the order of its precedence for transmission. The *Code time* is a similar abbreviation to indicate the exact time at which a communication is handed to the telegraph clerk for transmission; and the space marked "Words" is set apart for signalling to the distant station the number of words contained in a message which gives to the receiving clerk a check upon his correct reading of the signals by which the communication is transmitted.

In railway telegraphy the prefix D.R. (Danger) gives to the message precedence over all others, and should never be employed except in cases of great emergency. Other prefixes SP. (for special service), DB. (for ordinary traffic), and various others are employed in railway signalling, by which the degree of its urgency is indicated before the message itself is transmitted.

The system upon which the Code time is abbreviated is very ingenious, and will be readily understood by referring to Fig. 1, which we have borrowed from Mr. Langdon's book. Opposite the hour figures on the dial of a clock are placed the twelve letters, A, B, C, D, E, F, G, H, I, K, L, and M, and against the four minute divisions between the hour figures, are placed the letters R, S, W, X, which, as will be seen in the sketch, are repeated all round the dial A simple time-code is thus obtained, by which any hour or minute throughout the day can be expressed in from one to three letters; thus 2 o'clock would be signalled by B, 2.45 by B I, and 7.12 (the time shown in the figure) by G, B, S, that is, G for seven hours, B for ten minutes, and S for the remaining two minutes to make up the twelve.

The technical regulations for railway telegraphing and traffic management are treated very fully. In this the author's large experience from having had the superintendence of the telegraphs of one of the most important lines of railway in the country is most apparent and gives great weight to his remarks, which ought to be committed to memory by all concerned in the management of railways; for if rigidly enforced and carried out, railway accidents would become well-nigh impossible, except from failure of instruments, from the breaking-down of rolling-stock, or from damage to permanent way.

[1] During some portions of the day as many as seventy-five trains run through Clapham Junction Station in an hour, and between 900 and 1,000 is the daily aggregate average.

The second division of the book is devoted to the consideration of the block system, first conceived by Sir William Fothergill Cooke, and to the instruments and regulations by which that system which is the great guardian of the safety of railway travelling is carried out. It begins with a short historical notice of the subject, and, after explaining some of the elementary principles upon which the various instruments are constructed, proceeds to describe the different systems for carrying the block system into effect. The chapters devoted to this subject are embellished by a large number of excellent illustrations; each system being treated in a chapter to itself, which is a tolerably complete treatise on the subject.

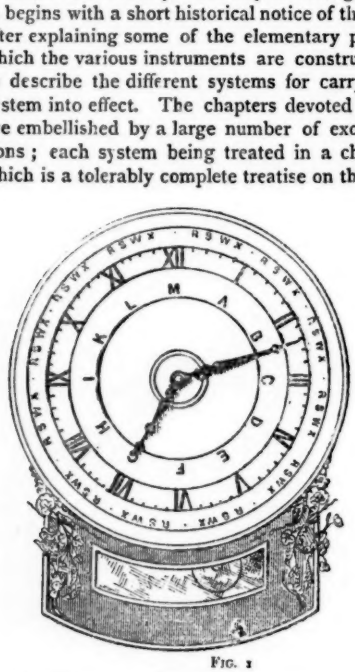


FIG. 1

The beautiful arrangements of Mr. Preece, in which the indications of the signalling instruments as well as their manipulation are identical with those of the outdoor signals, are clearly described, as well as the systems of Mr. Walker, of Messrs. Tyer, and of Mr. Spagnoletti, all of which are very extensively used in this country. The system of Messrs. Siemens Brothers so largely employed on the Continent, a description of which concludes this part of the book, is specially remarkable for the fact that in it batteries are dispensed with, the necessary electric currents for working the instruments being derived from small magneto-electric machines.

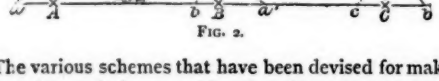


FIG. 2.

The various schemes that have been devised for making the train work its own signals, either by depressing "treadles" on the line, or by otherwise making electrical contacts, form a very interesting chapter, in which the systems of Mr. Imray, of London, of Mr. Rousseau, of New York, and of Dr. Whyte, of Elgin, are described and rendered clear by means of drawings and diagrams of the apparatus.

The essential principle of what is known as the block-system, is the insuring of there always being a certain distance between two trains travelling on the same line of rails. To carry this out the line is divided into a number of sections or "blocks," and the traffic is so regulated, that it is impossible for two trains to be in the same section at the same time. As a train enters one section, the signal behind it is set at danger, and is not lowered until the train has passed into the next section, which is similarly protected, and thus throughout the whole of its course a train cannot follow it at a distance less than the length of a section, or the distance between signal and signal. This is the one principle of the block system and all the various arrangements devised by different inventors differ only in the details by which it is carried out.

In Rousseau's arrangement, which may be taken as a

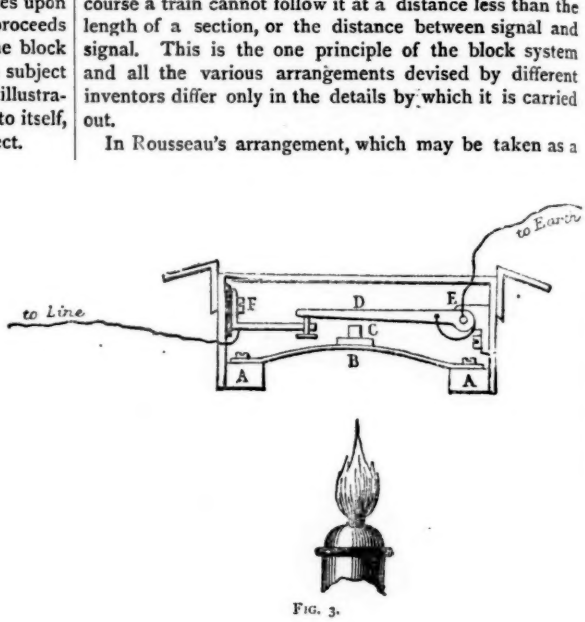


FIG. 3.

type of the automatic systems of block signalling, the train in its progress depresses treadles on the line, which, by making electrical contacts with suitable apparatus, set the signals at danger as the train enters one section, and releases them as it passes into the next. A general idea of this system may be obtained by referring to Fig. 2, in which A, B, and C represent three signals, and the spaces A B and B C two sections of the line; at *a* is a treadle by which A is set at danger, and at *a'* is another by which it is released; similarly a treadle at *b* sets the signal B at danger, and a

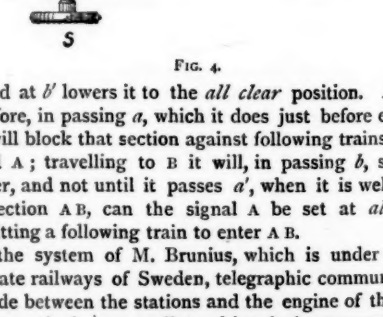


FIG. 4.

second at *b'* lowers it to the *all clear* position. A train, therefore, in passing *a*, which it does just before entering A B, will block that section against following trains by the signal A; travelling to B it will, in passing *b*, set B at danger, and not until it passes *a'*, when it is well out of the section A B, can the signal A be set at *all clear*, permitting a following train to enter A B.

In the system of M. Brunius, which is under trial on the state railways of Sweden, telegraphic communication is made between the stations and the engine of the train, so that not only can ordinary signals be transmitted to

the engine-driver, but he can receive instructions by telegraph.

Miscellaneous appliances employed in railway telegraphy are treated in the third division of Mr. Langdon's book, and an interesting chapter is devoted to the various "signal repeaters" and "light recorders." By the former, which were first employed by Mr. Preece, the position of the out-door signals is reproduced in miniature within the signal box, so that the signalman knows at once if the outside signals are correct. Light recorders are instruments which give warning, within the signal box, of the extinction of the light of the outside night-signals. Of these several forms have been devised but they all depend upon the expansion of metallic substances when subjected to the influence of heat and their subsequent contraction when that heat is removed. Fig. 3 is a cross-section of the transmitting portion of one of these instruments, in which B represents a concave disc of copper attached by its edge to the ring A A, a short distance above the flame of the lamp. When the light is out the lever D rests on the contact screw attached to the arm F (as shown in the figure) and the circuit is closed between the "line" and the earth, and an electric bell is set ringing in the signal box at the same time as an instrument indicates the words "*Light out.*" When, however,

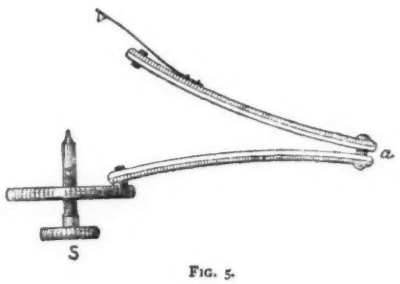


FIG. 5.

the plate B is heated by the flame below it, it becomes expanded, lifting the stud C, which, pressing against the lever D, lifts it off the contact screw, thereby breaking the circuit. The bell ceases ringing and the indicating instrument falls back to the signal "Light *in*."

Figs. 4 and 5 represent a different arrangement for producing the same result, in which the contact-maker consists of two compact bars of dissimilar metals, constructed after the manner of a metallic pyrometer, and united together at the end A with the similar metals facing one another. By this arrangement the arc of motion is largely increased and the instrument is in consequence rendered more sensitive. Under the influence of heat the bars curve in opposite directions, as shown in Fig. 5, but on the light becoming extinguished their differential contraction brings them to the position shown in Fig. 4, contact is established, the bell rings, and the signal "Light *out*," is transmitted to the receiving station.

The important subjects of the interlocking of points and signal levers, of level crossings, and the working of railway yards, all find their place in Mr. Langdon's book; and very interesting chapters are devoted respectively to the various kinds of electric bells, to lightning protectors or telegraphic instruments, and for the methods devised by different inventors and adopted by different railway companies for establishing intercommunication in trains.

It is not easy within the limits of the space at our disposal to do anything like justice to Mr. Langdon's most useful work, which is a thorough exposition of the subject in all its branches by one who not only has had a very large practical experience of the application of electricity to railway working, but who has the gift of clear description and a power of interesting his readers.

To all engaged in railway management whether directors, engineers, traffic managers, station-masters, signal-men, engine-drivers, or guards, Mr. Langdon's work will become a necessary text-book and book of reference, and the general scientific reader will find it most interesting and instructive. We must congratulate its author upon having put so much valuable information in so small a space, and its publishers upon having issued it in so cheap and attractive a form. C. W C.

TROLLOPE'S "SOUTH AFRICA"

South Africa. By Anthony Trollope. (London: Chapman and Hall.)

THERE are probably few of our Colonies the relations of which to one another are so little understood by the general public as those of South Africa, and none where events of so extraordinary a nature have occurred within the last few years. There are few Englishmen, therefore, by whom these charming volumes will not be read with delight and interest, coming as they do from a man of so much experience and of such liberal views as Mr. Trollope. The arrangement of the book is good and clear, each of the colonies being treated separately; a few chapters being devoted to a general introduction, and a few to the native tribes. The author has been led thereby into a somewhat unnecessary, possibly unconscious, repetition, when introducing each new district to his readers. This clearly arises from the fact that the origin of each colony is the same—the desire of the Boers to free themselves from British rule, their consequent occupation of new lands beyond the English border, and the necessity of our ultimately stepping in to govern them, both for their own good and for that of the natives. Mr. Trollope states that the objects of his interest are men and women, and it is to learn their condition, both socially and politically, that he visited South Africa.

Cape Colony, the oldest, largest, and most flourishing one, contains at present about 750,000 inhabitants, one third only of whom are white, and of the latter but one-third are English. These numbers indicate at once the very slow progress of the colony, and show that it is far from popular amongst emigrants, which Mr. Trollope thinks is due to the fact that here, and here only, the white labourer has to compete on equal terms with the native. The country seems closely to resemble the Riviera, though on a larger scale, both in scenery and capabilities. A great deal of the best lands, about 80,000,000 acres, is in private hands, of which only 550,000 acres are cultivated, being 1-145th of the private lands, and not one-fourteenth as Mr. Trollope has it. The great drawback to the country is the want of irrigation works when almost every European plant could be grown. Amongst other things, has not the cultivation of

the olive been tried? We have nowhere seen any account of such an attempt. One would suppose that it would grow well, and in that case could not fail to be very remunerative. The people are well-to-do, and the rate of wages is good. When one, however, compares what is done here and in the United States in the way of irrigation works, in the scientific investigation of the country with reference to mining and agricultural pursuits, and in the collection and examination of the objects of scientific interest, one cannot but feel that there is a sad lack of enterprise and energy in the colony. The Cape Town Museum seems to be in a semi-starved condition.

The white population of Natal is almost entirely English, the Dutch having withdrawn for the most part as soon as the English Government decided on interfering. Sugar seems likely to form the staple of the colony. It is cultivated with the aid of coolie labour, although the Zulus are to the white population as sixteen to one.

In the Transvaal and the Orange Free State the Dutch form the agricultural, the English the town and trading population. Mr. Trollope seems to possess that genial disposition which draws out the bright side of the people with whom he is brought in contact. Although, therefore, he finds the Boer wanting in cleanliness, education, sociability, and enterprise, he finds in him many good points, and is far from thinking him so bad or so hopeless as the author of "The Great Thirst Land." The Boer has improved of late years, and in some cases considerable pains are taken with the education of the children. As Mr. Trollope says, "The Dutch Boer is what he is, not because he is Dutch or because he is a Boer, but because circumstances have isolated him."

Three chapters are devoted to the diamond diggings, and a very interesting plan of the great Colesberg Kopje is given. The author has very little sympathy with diamond-digging, and the only satisfaction he finds there is the civilising influence which the employment of so many natives cannot fail in time to exert. Mr. Trollope has devoted considerable thought and attention to the native question. His opinion is one well worthy of attention, though it is not likely, he thinks, to be regarded with favour either by Exeter Hall or the Colonists whose lands lie uncultivated for want of labour. He visited several of the Missionary Institutions, all of which, with the exception of M. Esselin's self-supporting one at Worcester, seem to have been more or less failures. He thinks that work, steady and regular but voluntary, will be found to be the best and most effective civilising agents. Unfortunately the natives' wants are so few and so easily satisfied, that there is at present no spur to regular work.

The account of Bloemfontein as a sanatorium for consumptive people is that of a man of "heroic mould" equal to the feat of dining twice daily, such as Mr. Trollope must be, seeing that at his age he makes light of, and seems to have enjoyed, the rough travelling by mail-carts, cape-carts, and otherwise, of considerably over two thousand miles. One regrets that he has not mentioned whether there is here the same change between morning, midday, and evening climate as he observed at Pretoria; also whether he came across any consumptive people, and how they fared. He also forgets that deal benches and chairs constructed with an equal regard to human anatomy, judging from the fact that easy chairs cost 13*l.* 10*s.* each, are not the seats most likely to conduce to the comfort of an invalid.

An excellent map accompanies the book. The type, paper, and "get-up" are all that can be desired, and the number of misprints is small. W. J. L.

OUR BOOK SHELF

The Science of Language. By Abel Hovelacque. Translated by A. H. Keane. (Chapman and Hall, 1877.)

WE have already had occasion to review at length the original French text of this work, which is now presented in an English dress. M. Hovelacque is one of the most distinguished representatives of the school of comparative philologists who would include their study among the physical sciences, and his book illustrates both the faults and the excellences of the view he upholds. In spite of the limitations thus introduced into the science of language, in spite, too, of the many inaccuracies which occur in his descriptions of the various groups of language at present existing in the world, the clearness and vigour of his style make his book one well worth translating, and it is satisfactory to see that it has been put into competent hands. Mr. Keane has added to the value of the work by a philological map, and a tabulated list of the languages described by M. Hovelacque, together with their characteristics and geographical position. From time to time, too, he has introduced foot-notes and even insertions in the text; many of these give fresh information or correct the statements of the author; others of them, however, had better been left unwritten. Thus his reference to Raabe's attempt to connect Aryan and Semitic grammar is not very happy, and he is unfair towards his author when he accuses him of inconsistency in being at once a Darwinian and a polygenist. No doubt "the impossibility of reducing man now to, say a mollusc, is no argument against the original identity of man with a mollusc" (or rather of his descent from the same form of life as a mollusc); but that is because there are intermediate links and stages of development between the mollusc and man, and M. Hovelacque believes—and with good reason—that such intermediate links do not exist between the manifold families of speech that are scattered over the world.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Age of the Sun in Relation to Evolution

IT has been urged by Mr. Plummer (pp. 303 and 360) as a fundamental objection to the theory that sun-stars are formed from the collision of stellar masses, that if the theory be true there ought to be many of the stars moving with great velocities, which he affirms is not the case. But I am unable to understand upon what grounds he bases his assertion. I freely admit that if it could be proved that none of the stars has, as he seems to suppose, a proper motion of more than thirty or forty miles per second, it would at least be a formidable difficulty in the way of accepting the theory. For it would indeed be strange, as Mr. Plummer remarks, "that amid all the diversity of dimensions of the heavenly bodies, it should invariably happen that the resultant movement of the combined masses should be reduced to such insignificant figures as the above." But how does Mr. Plummer arrive at the conclusion that something like this must invariably

have taken place? I fear that before his objection can be fairly urged something more definite must yet be known as to the rate of motion of the stars.

All that we are at present warranted to affirm, I presume, is simply that of the comparatively few stars whose rate of motion has been properly measured, none has a motion greater than thirty or forty miles per second, while nothing whatever is known with certainty as to the rate of motion of the greater numbers of stars. Before we can ascertain the rate of motion of a star from its angular displacement of position in a given time we must know its absolute distance. But it is only of the few stars which show a well-marked parallax that we can estimate the distance, for it is now generally admitted that there is no relation between the apparent magnitude and the real distance of a star. All that we know in regard to the distances of the greater mass of the stars is little more than mere conjecture. Even supposing we knew the absolute distance of a star and could measure its amount of displacement in a given time, still we could not be certain of its rate of motion unless we knew that it was moving directly at right-angles to the line of vision, and not at the same time receding or advancing towards us; and this we could not determine by mere observation. The rate of motion, as determined from its observed change of position, may be, say, only twenty miles a second, while its actual velocity may be ten times that amount.

By spectrum analysis it is true we can determine the rate at which a star may be advancing or receding along the line of sight independently of any knowledge of its distance. But this again does not give us the actual rate of motion unless we are certain that it is moving directly to or from us. If it is at the same time moving transversely to the observer, its actual motion may be more than 100 miles per second, while the rate at which it is receding or advancing, as determined by spectrum analysis, may not be twenty miles a second. But in many cases it would be difficult to ascertain whether the star had a transverse motion or not. A star, for example, 1,000 times more remote than *a* Centauri, that is, twenty thousand billion miles, though moving transversely to the observer at the enormous rate of 100 miles per second, would take upwards of thirty years to change its position so much as 1″ and 1,800 years to change its position 1′. In fact, we should have to watch the star for a generation or two before we could be certain whether it was changing its position or not. And even after we had found with certainty that the star was shifting, and this at the rate of 1′ in 1,800 years, we could not, without a knowledge of its distance, express the angle of displacement in miles. But from the apparent magnitude or brilliancy of the star we could not determine whether its distance was ten times, 100 times, or 1,000 times that of *a* Centauri and consequently we could form no conjecture as to the actual velocity of the star. If we assumed its distance to be ten times that of *a* Centauri, this would give a transverse velocity of one mile per second. If we assumed its distance to be 100 times that of *a* Centauri, this would give ten miles a second as the velocity, and if 1,000 times, the velocity of course would be 100 miles per second.

As there are but few of the stars which show a measurable parallax and having no other reliable method of estimating their distances, it follows that in reference to the greater number of the stars neither by spectrum analysis nor by observation of their change of position can we determine their velocities. There does not therefore appear to be the shadow of a reason for believing that none of the stars has a motion of over thirty or forty miles per second. For anything that at present is known to the contrary, the majority of them may possess a proper motion enormously greater than that.

There is, however, an important point which seems to be overlooked in Mr. Plummer's objection, viz., that unless the greater part of the motion of translation be transformed into heat, the chances are that no sun-star will be formed. It is necessary to the formation of a sun which is to endure for millions of years, and to form the centre of a planetary system like our own that the masses coming into collision should be converted into an incandescent nebulous mass. But the greater the amount of motion left unconverted into heat, the less is the chance of this condition being attained. A concussion which would leave the greater part of the motion of translation untransformed would be likely as a general rule to produce merely a temporary star, which would blaze forth for a few years or a few hundred years, or perhaps a few thousand years, and then die out. In fact we have had several good examples of such since the time of Hipparchus. Now, although it may be true that according to the law of chances, collisions producing temporary stars may be far more numerous than those resulting in the formation of permanent stars, nevertheless the number of those temporary stars observable in the heavens may be perfectly insignificant in comparison to the number of permanent stars. Suppose there were as many as one hundred temporary stars formed for one permanent, and that on an average each should continue visible for 1,000 years, there would not at the present moment be over half-a-dozen of such stars visible in the heavens.

JAMES CROLL

The Age of the Earth

WITH reference to the ingenious suggestion by Mr. Preston, on the earth's orbit having been practically diminished by ethereal retardation, there are a few other points to be considered. 1. That the minor planets could never have passed the major planets, as they would be certainly caught by them during the immense number of revolutions in which their orbits would be nearly equal. Therefore the earth cannot have dropped in from much farther than Jupiter's present orbit; for if during its revolutions it came within one-sixth of the distance from Jupiter that it now is from the sun, it would be mastered by Jupiter. 2. By the retardation of Encke's comet it seems that if the comet had the same orbit as the earth, its distance from the sun would diminish about $\frac{1}{28000}$ per year. But for any appreciable lengthening of the earth's life-period, the earth must have started much more than one-tenth farther from the sun than it now is; that is to say, it must fall in much quicker than at the rate of its present distance from the sun in 10^8 years. This shows that the individual portions of Encke's comet must be much more than two miles in diameter, even supposing it to have as great a mean density as the earth, and to consist of a shower of solid meteors. Thus if the earth's history should be lengthened by any important amount from this cause, the nucleus of Encke's comet must consist of a shower of bodies of as great a density as the earth, and of a considerable size, each weighing very much more than 100,000,000 tons. And considering that there must be thousands of such bodies to compose it, the total mass would be greatly beyond what is considered possible. 3. If the earth had drawn much nearer to the sun, the asteroids must have come in from a very much greater distance; and yet, though they differ greatly in size, they are all grouped closely together, whereas we should find then sorted out very much more widely, and a vast quantity of them retained by Jupiter as satellites.

The solar system appears to be really a quinary system of stars; the major planets being analogous to the sun in their characteristics of density, distances and proportions of satellites, and other elements, the minor planets being the sun's satellites. Thus it is seen that the uniform law of satellites is to regularly decrease in volume both close to, and farthest from, their primaries; the series manifestly terminating in asteroids in the case of the sun and of Saturn.

In the whole of the present discussion of the earth's age, what is the reason why only one out of several different limits is considered? 1. The decrease of temperature in the earth. 2. Tidal retardation. 3. The cooling of the sun, which is recognised as being the weakest of the three. 4. A uniform diffusion of temperature in the earth, which gives a limit, not for life, but for the separate existence of the earth. The close agreement of the limits of life history given by these first three methods is a very strong argument in favour of each of them; for if there is even a possibility of 1 in 5 that each separately is wrong, it would be less chance than 1 in 100 that the concordance of all three was wrong.

Is there anything so stable and certain in geologic time—when we remember that levels permanently alter as quickly as ten feet per century—that rainfall (and therefore denudation) depends mainly on the almost unknown changes in the sun's heat, a slight increase of rainfall making much greater rapidity of denudation—and that accumulation of peat and stalactite might well become proverbial for its variability—when all these uncertainties are remembered, is there anything so indubitable as to warrant our throwing all the odium of incorrectness on the cosmical chronology, and seeking to square it with geological suppositions?

W. M. FLINDERS PETRIE

Bromley, Kent

The "Eurydice" Squall

THE loss of H.M.S. *Eurydice* on the 24th ult. may perhaps give a melancholy interest to a plain statement of the facts connected with the meteorology of that day.

The squall in which she capsized was one of a common class which occur when, after a long steady fall of the barometer, the mercury pauses for a few hours before commencing to rise. These squalls differ considerably from simple squalls, and are frequently complicated, as in this case, with small secondary cyclones.

Since the 20th inst. the general type of weather over our islands had been very uniform, an area of high pressure being constantly found over the west of Ireland, with a constantly low pressure near Stockholm giving cold north-west winds, conditions which are very common in the month of March. But while the general shape of the isobaric lines remained constant, the absolute pressure over the whole area had been diminishing rapidly till the 24th inst. On the morning of that day, the centre of a cyclone was near Stockholm, while no less than three secondary depressions were influencing Great Britain, and by 6 P.M. the whole system had gathered itself into two small cyclones whose centres were near Yarmouth and Bergen.

Such a development of secondaries with a north-west wind is not common, and is always associated with exceptionally wild and broken weather, of the kind which gives heavy local rainfall, with squalls, or violent cold thunderstorms, but not widespread or destructive gales.

In London the changes above described were well shown by a steady fall of the barometer from the 21st inst., which amounted to an inch at 3.45 P.M. on the 24th. As a heavy squall came on then, the barometer jumped up suddenly two-hundredths of an inch, as is often the case in squalls, and then fell slowly in about a quarter of an hour to its former level, where it remained stationary till about 9 P.M., after which it rose steadily. The squall, which lasted about twenty minutes, was followed by very threatening-looking weather, during which the wind perhaps backed a little to west-north-west, but at 4.40 P.M. it shifted to north-north-east and became strong, with heavy snow, till 5.20, when the weather moderated, the whole being evidently due to the complicated action of one of the secondary depressions before mentioned.

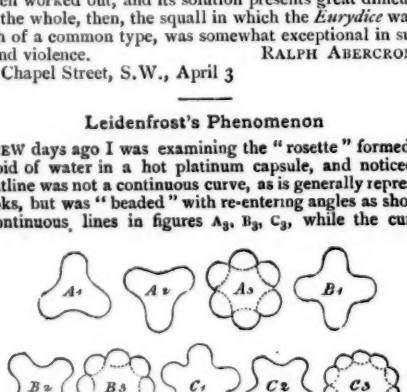
Materials are still wanting for tracing the connection between the squall in London at 3.45 P.M., and that at Ventnor at the same hour, but squalls often do occur simultaneously at distant places in connection with the trough of great non-cyclonic barometric depressions. The question of any such relation has not yet been worked out, and its solution presents great difficulties.

On the whole, then, the squall in which the *Eurydice* was lost, though of a common type, was somewhat exceptional in suddenness and violence. RALPH ABERCROMBY

21, Chapel Street, S.W., April 3

Leidenfrost's Phenomenon

A FEW days ago I was examining the "rosette" formed by a spheroid of water in a hot platinum capsule, and noticed that the outline was not a continuous curve, as is generally represented in books, but was "beaded" with re-entering angles as shown by the continuous lines in figures A_3, B_3, C_3, while the curve of



each bead could be distinctly traced within the drop, forming a "fluted" outline, shown by the dotted lines in the same figures. It was at once manifest that both the "beaded" and "fluted" figures were produced by the superposition of the retinal images of the drop in two extreme conditions of vibration; that, in the case represented by A_3, the drop was really vibrating like a bell which is sounding its first harmonic above its fundamental note, and therefore possesses six ventral segments, the extreme forms assumed being represented by A_1 and A_2 respectively, and that B_3 and C_3 represent the appearance of the drop when vibrating like a bell which is sounding its second and third harmonic respectively. To verify this a spheroid of about five-eighths of an inch in diameter was produced; and as soon as the beaded decagon, C_3, was steadily maintained, the room was darkened, and the spheroid illuminated by sparks from Holtz's machine. Immediately the curvilinear pentagons C_1 and C_2 were apparent, and frequently the vibrations continued perfectly steady for several seconds. When the drop had diminished in size the mode of vibration changed, and the crosses represented by B_1 and B_2 appeared when the sparks passed; on opening the shutters the beaded octagon B_3 appeared almost perfectly steady in the capsule. The figures A_1, A_2, and A_3 were obtained in the same manner, and with a larger spheroid twelve and sixteen beads were obtained, presenting respectively curvilinear hexagons and octagons when illuminated by the sparks. In one case a small spheroid presented a very large number of beads in its outline; but on examining it with sparks it was found to be produced by the crosses B_1 and B_2 rotating very rapidly about a vertical axis. Two or three particles of carbon introduced into a spheroid remained for a long time close to the surface of one "ventral segment," like lycopodium powder on a Chladni's plate, and when they escaped from it were ensnared by the next segment. The figures observed when the spheroids were illuminated by sparks were fully as exorbitant as those shown at A_1, A_2, B_1, B_2, C_1, and C_2.

If the spheroidal form be due to the combined action of gravity and surface tension, it is obviously to the latter force that we must look for the production of vibrations when, by any accident, the spheroid is disturbed. The amount of steam produced from the under-side of any "ventral segment" will, of course, be greater the greater the surface exposed; and when this is a fresh surface, will increase as the surface becomes heated by exposure. Hence the amount of steam escaping from beneath a "ventral segment" will be greater as it is contracting towards, than when it is moving from, the centre of the spheroid, thus supplying, on the whole, during each vibration an impulse in the direction of motion. It seems unnecessary to look farther for a supply of energy. WM. GARNETT

Cavendish Laboratory, Cambridge, March 15

Trajectories of Shot

HAVING observed a letter in NATURE, vol. xvii. p. 401, in which extracts from a paper of mine are commented upon by the Rev. F. Bashforth, I trust you will let me make a few remarks by way of explanation.

In the paper referred to I was trying to weigh against one another the merits of different methods of finding the trajectories of shot, the calculations being, of course, based upon Mr. Bashforth's tables; and the method which I liked the best did not contain the equation (a), which is the text of Mr. Bashforth's letter. Now without doubt the method I preferred had faults of its own, but it was a sort of argument in its favour if I could show that the other methods were not faultless, and in particular if I could show that the equation (a), which is the key of those other methods, had no merits of severe accuracy to set off against certain defects which I thought it might fairly be charged with.

The objections I had to the equation (a) are partly set forth in the first extract quoted by Mr. Bashforth; but one great objection to it is the tediousness of its application in practice. Mr. Bashforth appears to be greatly offended with my description of the way the equation is used, viz., that it is a process of guessing. But he cannot pretend that he has solved the equation according to any strict method; he has only guessed at a solution which falls in more or less with his tables. It seems to me he is here quarrelling about a mere name, because the process he describes and indeed illustrates is practically the process I describe, and it is idle on his part to give me the information contained in his letter, because I am very well aware that the second guess gives a better result than the first. But as regards the amount of accuracy belonging to the equation, I must still hold by the substance and tendency of my remarks on that subject, except in my unfortunate use of the epithet "dangerous," which I admit was extreme. I frankly confess that the force of the argument derived from discussing the values of $\frac{dk}{dv}$ is materially weakened when those values are numerically exhibited and compared with the tables. At the same time, when taken in connection with the peculiar way the equation is used, the numbers,

such as I make them roughly, do not convince me that the argument is without force. My chief criticism on the equation has two branches:—1. Mr. Bashforth has nowhere proved that he is entitled to use the k belonging to the mean velocity over the arc. 2. Granting that he may use that k, we have then to consider whether he has got v_θ and k to accord. For my part, I do not feel the degree of certainty which Mr. Bashforth expresses about this, especially if the work is carried over a considerable arc. I will grant that his result comes near the truth, but assuredly he cannot be said to have determined v_θ *accurately*, as he affirms.

I cannot help thinking that there is no real difference between Mr. Bashforth and myself, for all that I have said against the equation (a) can be said in another form against the method that I prefer, and I willingly indorse the statement in the last paragraph but one of his letter. I may be allowed to add that all methods hitherto proposed of calculating shot ranges seem to me too difficult for common use, and I believe what would really be a boon to the artilleryman is a book of trajectories drawn to scale. This might be accomplished very well by Mr. Bashforth's tables and methods in the hands of some one competent to use them, the simpler methods, as I think them, introduced by me, being also of some service. I trust this will be done when the resistance to shot moving with low velocities has been ascertained, as I hear it is to be, by a series of experiments under Mr. Bashforth's superintendence.

Allow me in conclusion to express my regret that I should seem to have been reviewing in a hostile spirit any part of the work done by Mr. Bashforth at Woolwich. I will only assure him that nothing could have been further from my thoughts than to do so. W. D. NIVEN

Trinity College, Cambridge, March 30

The Daylight Meteor of March 25

A CORRESPONDENT in NATURE described the falling of a daylight meteor on Monday, March 25. I have received information respecting this meteor from five persons who witnessed its fall.

Mr. McIntyre, who saw it from near Dunston-on-Tyne; Mr. Wood, banker, who saw it whilst leaving his residence at Benton, near Newcastle-on-Tyne; Mrs. Hopper, from Gosforth, one mile north of Newcastle; Mrs. Lupton, who saw it from a railway carriage at Brampton, near Carlisle; and Mr. W. Clarke, of Newburn, who saw it at Wallbottle, four miles west of Newcastle. All these observers agree in the following particulars:—1. That the meteor was visible at 10.20. 2. That it was very luminous with a white light slightly coloured. 3. That it fell at a slight inclination from E. to N., and reached the horizon at or near the north point. 4. That the weather was clear and the sun shone brightly at the time the meteor was visible. T. P. BARKAS

26, Archbold Terrace, Newcastle-on-Tyne

Meteor

ON the night of Tuesday, April 2, at about 7.55 o'clock, I was standing with two companions, facing the north, when we were surprised to observe the ground before us suddenly lighted up, and our three shadows sharply defined upon it. One of my friends exclaimed, "Why, there's the moon come out!" We turned round and beheld a wonderfully brilliant meteor descending almost perpendicularly from about 5° east of Betelgeux, in Orion, towards the most eastern of the three stars in the belt. Its course was slightly zig-zag, its colour yellow or orange, its apparent size about half the diameter of the full moon. It vanished noiselessly before reaching the belt, and left no visible remains. When we first saw it there appeared be a short trail of light behind it. About three minutes after its disappearance a rumbling sound was heard like distant thunder, from the same direction. Whether this was connected with the meteor I cannot tell. If so it would indicate a distance of about forty miles, and we ought to hear of this meteor from the neighbourhood of Warwick. F. T. MOTT

Birstal Hill, Leicester

[The same meteor was seen by several *Times* correspondents. It made its appearance in Ursa Major, and after remaining stationary for a second or two between Orion's Belt and Sirius, fell at a comparatively slow rate and in a direct line to the horizon. It was pear-like in shape, seemed three or four times larger than Jupiter, and was intensely bright. Its colour changed from a silvery white to a pale red as it approached the horizon, where it disappeared behind a cloud, leaving a long track of light behind it.]

To Entomologists

As I have undertaken the section "Arthropoda" for the "*Jahresbericht für Anatomie und Physiologie*, of Hoffmann and Schwalbe," and find some difficulty in obtaining English scientific journals (specially the entomological ones) here in Naples, will you permit me through your columns to request such of your readers as may have published papers on the *anatomy*, *ontogeny*, and *phylogeny*, of the *Hexapoda*, *Myriapoda*, *Arachnoidea*, *Protracheata*, *Poecilopoda*, and *Crustacea* in 1877, or intend to do so in 1878 and the following years, to be kind enough to forward me a copy of them, or at least to inform me of the fact? PAUL MAYER

Naples, Stazione Zoologica, March 31

GEOGRAPHICAL NOTES

ROYAL GEOGRAPHICAL SOCIETY MEDALS.—The Founder's Medal for 1878, of the Royal Geographical Society, has been awarded to Baron F. von Richthofen for his extensive travels and scientific explorations in China; also for his great work now in course of publication, in which the materials accumulated during his long journeys are elaborated with remarkable lucidity and completeness. The Patron's Medal has been given to Capt. Henry Trotter, R.E., for his services to geography, in having conducted the survey operations of the late Mission to Eastern Turkistan, under Sir Douglas Forsyth, which resulted in the connection of the Trigonometrical Survey of India with the Russian Surveys from Siberia, and for having further greatly improved the map of Central Asia. Mr. Stanley, being already a medallist, is disqualified from receiving a similar honour, but he has been elected an honorary corresponding member, and is to receive the thanks of the Council for his discoveries.

AFRICA.—With a view to facilitating the progress of the London Missionary Society's contemplated expedition from the East Coast of Africa to Lake Tanganyika, the Rev. Roger Price, who had had long experience of roads and waggons in South Africa, was despatched to Zanzibar in 1876, to make investigations respecting a new route and new mode of travelling into the interior. He made the experiment of using bullocks and waggons in the place of *pagazi*, and with so much success that it was resolved that the expedition should adopt that mode of conveyance for themselves and their goods, and a flourishing account of the new scheme was given before the Royal Geographical Society on February 26, 1877. Before the expedition arrived at Zanzibar in the summer of last year, Mr. Mackay, an agent of the Church Missionary Society, was reported to have cleared a road nearly, if not quite, as far as Mpwapwa, and it was supposed that the expedition would reach the Lake with great ease. Their hopes, however, have been grievously disappointed. The road has turned out to be no road at all, and most of the oxen have died from the effects of the climate. Mr. Price returned to England some little time back, convinced, we believe, of the present impracticability of his bullock-waggon scheme, and sad to relate, it has been found necessary to revert to the old *pagazi* system, the curse of African travel. By latest accounts the expedition had formed a camp at Kirasa, in Usugara, on the edge of the high plateau, and about forty miles east of Mpwapwa, and there they intend to remain till after the rainy season.—Lieut. J. B. Wathier has been appointed to join the Belgian expedition at Zanzibar, which recently lost two of its members, MM. Crespel and Maes. He has visited Dr. Nachtigall at Berlin, to obtain the advice of the experienced explorer, and left Brindisi for Zanzibar on the 5th inst. Dr. Nachtigall himself, as leader of the German expedition, is to start from St. Paul de Loanda, and it is hoped that the two expeditions may meet in the centre of Africa.

On the 5th inst. Lieut. de Semellé left Bordeaux for the purpose of setting out on his proposed journey across Africa from Senegambia. The Society of Algerine Catholic Missions has obtained from the Pope an authorisation to send two parties of priests into the interior of Africa; one, under the direction of Father Pascal, will establish a *vicariat apostolique* on the banks of Lake Tanganyika; the second party, whose head is said to be Father Livinzac, will establish a similar organisation in the region of the Nyanzas. The missions will be scientific as well as religious.

ARCTIC EXPLORATION.—A wealthy Russian merchant M. Sibiriakoff has offered the sum of 12,000 roubles to the Committee of the Dutch Arctic Expedition, on condition that the Committee should order that the Siberian coasts be specially explored by the Expedition. The Committee has, however, refused the offer, on the one hand because it was considered undignified to accept foreign help for a purely national undertaking, and on the other, because the expedition has a specifically scientific and not a commercial object. This offer of M. Sibiriakoff seems unnecessary, seeing that the Siberian coast is likely to be explored this summer by Prof. Nordenskjöld in the *Vega*. We may remind our readers that this expedition sets out in the beginning of July, for the purpose of forcing the North-East Passage from Europe to Behring's Straits. Prof. Nordenskjöld has made a thorough study of the records of Russian exploration along the north coast of Siberia, and concludes that in early autumn the ice retires from the coast as a rule, leaving a comparatively clear waterway. Even should the immediate aim of the expedition not be accomplished, we may expect large additions to our knowledge of the hydrography, geology, and natural history of these regions, which, from a scientific point of view, have been comparatively unexplored. Prof. Nordenskjöld conjectures that a line of islands separates the Siberian from the strictly Polar Sea, of which we only know Wrangell Land and New Siberia; he will endeavour to verify this conjecture. The proposal has been made in the first Chamber of the Swedish Reichstag to grant the sum of 22,000 Swedish crowns for the Arctic Expedition projected by Lieut. Sandeberg, the costs of whose exploration in Lapland, to which we have already referred, were defrayed entirely by himself.

CAIRO GEOGRAPHICAL SOCIETY.—**At an extraordinary meeting of this society on February 16 the question of its existence was discussed; it had become almost extinct from want of funds. It was proposed to join it to the Egyptian Institute, thereby much diminishing its working expenses, and putting it in an advantageous position for carrying on its work. We hope the scheme will be carried out, as the situation of the society places it in an unusually favourable position for carrying on the work of African exploration.**

SOUTH AMERICA.—Advices from Valparaiso state that Commander Paget, of Her Majesty's ship *Penguin*, communicated to the captain of the port of Coquimbo that while passing through Messier's Channel, on January 10, he saw a volcano in eruption, situated E. ¼ S. (Mag.) of the southern extremity of Middle Island, English Narrows. It is supposed that this volcano is the cause of the subterranean noises heard by an exploring party from the corvette *Magallanes*, near Lake Santa Cruz, in the middle of December, and is the same as that believed to exist by the Argentine explorer Moreno. *Apropos* of the foregoing, says the *Timpos*, one of the most remarkable discoveries made by Chilian explorers is the complete disappearance of the Andes chain at the southern extremity of the continent. Messrs. Rodgers and Ibar crossed from Brunswick Peninsula, situated, according to the Argentines, to the east of the Andes, to the Pacific, arriving at a place called by Fitzroy the plains of Diana, without meeting with vestiges of the Cordillera. There are plains, more or less inclined, but only plains.

ETHNOGRAPHY OF RUSSIA.—**As Supplement 54 to Petermann's *Mittheilungen*, Col. Rittich's valuable and elaborate treatise on the ethnography of Russia has just been published, with a large map, coloured with the greatest care, and showing with wonderful clearness the many elements which go to make up the Russian population.**

THE YENISSEI.—To the April number of the *Geographical Magazine* Mr. Seebohm contributes a paper on the Valley of the Yenissei, embodying some of the results of his recent voyage to that river.

THE WHANG-HO.—In the same number is the first instalment of an exhaustive paper on this river, with special reference to its double delta, by Mr. Samuel Mossman.

EDUCATIONAL VOYAGE.—**A voyage around the world, designed for students, is being arranged at Paris. It will last eleven months, over six months being devoted to various land excursions. Books, collections, &c., will be taken, and the entire programme will have instruction, rather than sight-seeing, in view. It is intended to depart on June 15.**

PARIS GEOGRAPHICAL SOCIETY.—**The January *Bulletin* of this Society contains the first part of an important inquiry into the medical geography of the West Coast of Africa, by Dr. H. Rey, and also the first instalment of a narrative of a journey in Cilicia in 1874 by MM. C. Favre and B. Mandrot. M. Nogueira gives a translation of a paper from the Portuguese on the South African river Cunene.**

The Council of the Society of Geography has issued its list of candidates for the high offices of the society. It proposes to the members to elect Admiral La Roncière le Nourry, who has been voted six or seven times almost without opposition. But a number of independent members are proposing, in opposition, the nomination of the present Minister of Marine.

DEPTHS OF LAKES.—*The Bavarian Courier* publishes an interesting comparative statement of the depths of lakes. Amongst European lakes the Achensee, in the Tyrol, heads the list. At some points the depth of this lake amounts to 772 metres. The greatest depth of the lake of Constance is about 300 metres, that of the Chiemsee about 141 metres, and that of the Walchen- and Königssee, 188 metres. The measurements made about 1870 at the Dead Sea showed that at its deepest part the depth is 565 metres, but if we consider that the level of this lake is already 429 metres below the level of the Mediterranean, then we find that the total depression in the soil here amounts really to 994 metres. The Lake of Tiberias is extremely shallow in comparison; on its eastern part the average depth is only eight metres, while on the western side it lies between six and seven metres. In Lake Baikal depths have been found which for a lake are truly astonishing. In the upper part of the lake the depth is 3,027 metres (about the height of Mount Etna), but downwards the bottom constantly descends, and near the opposite bank the depth amounts to 3,766 metres. This depth far exceeds that of the Mediterranean Sea, which at its deepest part measures only 2,197 metres.

GERMAN ALPINE CLUB.—**The German and Austrian *Alpen Vercin*, although comparatively young, has developed a most praiseworthy activity in a variety of directions. From the last general report we notice that it has a membership of nearly 7,000, and an annual income of 40,000 marks. The chief exertions are devoted to the erection of shelter huts in the Alps, and maintenance of communications over the passes. It is, however, rendering no slight service to the cause of geography, by the**

gradual preparation of elaborate maps of the German and Austrian Alps. At present it is engaged on a map of the Salzkammergut, on a scale of 1 : 100,000.

A LUNAR LANDSCAPE

MESSRS. GAMMON AND VAUGHAN, No. 28, Old Bond Street, have at present on view a picture in which the artist, Olafs Winkler, of Weimar, has endeavoured to represent a lunar landscape. Prof. C. Bruhns, of Leipzig, has assisted him in the parts of the treatment which are directly scientific.

The painter has not trusted all to his imagination. He has, to the best of his knowledge and ability, sought to stick rigidly to truth, and to paint a lunar landscape such as it would appear, so far as human observation has hitherto ascertained, to a human eye, were it at all possible for a man to be transplanted to the moon and observe through his earthly eyes, only for a moment, nature as she manifests herself on the surface of our satellite. From the merely artistic point of view the artist fears his task may be a thankless one, for since the moon has no atmosphere, there is neither aërial perspective nor diffusion of light, but it is precisely this point which should make our artist all the more interested in this unique production. The shadow of a body in the foreground will appear quite as black as the sky itself which closes the landscape like a flat steep wall, broken only by the quiet light of the stars. All lights appear equally strong at a distance and close at hand, and this also holds with the local colouring. In a word, there is wanting in the lunar landscape that which lends to our earth perspective, richness of tone, modulation, softness, and temper. It is our atmosphere we have to thank for most of the multitudinous coloured phenomena of the terrestrial landscape—phenomena which in our satellite are impossible. The sunlight falls upon the hills with blinding brightness, and cuts sharply across the deep black shadows. Its intensity rivals the electric light, and light effects of such a kind are far beyond the reach of our palettes. We must resort to some expedient to be able to introduce a medium between the extreme contrast of light and shade, a sort of half-tone, which, at the same time, must be the chief tone of the picture; this Herr Winkler has sought in the light of the earth, the true "earthshine."

The artist has chosen the time of sunset, and the region he has selected lies in the northern part of the moon. The spectator is supposed to be on the front slope of a mountain, the continuation of which in the background comes out as a closed ridge. At his feet one of the numerous *maria* spreads out, filled up with rills, circular hills, and large and small craters, stretching away to the distant mountain referred to. Before, us in the black sky, hangs the moon's moon, our earth. She sheds her pale, ash-coloured light over the rent, desolate, dead stone-fields. Only the highest points of the mountain-tops still glow in the light of the setting sun, no longer red, as here, but dazzlingly white, in consequence of the absence of atmospheric absorption. The earth is at the period of her course between Sagittarius and the Scorpion, Antares being nearly in the middle of the picture. Against his persuasion he has been compelled to make the milky way very weak, and the stars somewhat large in proportion to the earth.

Herr Winkler, in a paper read at the last meeting of the German Association, stated that his first impulse to undertake the picture was derived from Nasmyth and Carpenter's work on the moon.

Our only criticism of the picture refers to the colour of the earth and of the true earthshine. We doubt whether the earth is quite red enough, especially at the edges, and we doubt again whether, with the earth as ruddy as it is, the colour of the lunar landscape itself should not be rather more in harmony with it, as it is the true light source.

The picture is an admirable performance, and the science of it is so true that, as we hinted before, those of our artists who care to have a natural basis for their depiction of natural phenomena will learn much from such an attempt at dealing with a new order of things.

EDISON'S TALKING-MACHINE[1]

MR. THOMAS A. EDISON has recently invented an instrument which is undoubtedly the acoustic marvel of the century. It is called the "Speaking Phonograph," or, adopting the Indian idiom, one may aptly call it "*The Sound-Writer who Talks.*" Much curiosity has been expressed as to the workings of this instrument, so I purpose giving an account of it.

All talking-machines may be reduced to two types. That of Prof. Faber, of Vienna, is the most perfect example of one type; that of Mr. Edison is the only example of the other.

Faber worked at the source of articulate sounds, and built up an artificial organ of speech, whose parts, as nearly as possible, perform the same functions as corresponding organs in our vocal apparatus. A vibrating ivory reed, of variable pitch, forms its vocal chords. There is an oval cavity, whose size and shape can be rapidly changed by depressing the keys on a key-board. A rubber tongue and lips make the consonants; a little windmill, turning in its throat, rolls the letter *r*, and a tube is attached to its nose when it speaks French. This is the anatomy of this really wonderful piece of mechanism.

Faber attacked the problem on its physiological side. Quite differently works Mr. Edison: he attacks the problem, not at the source of origin of the vibrations which make articulate speech, but, considering these vibrations as already made, it matters not how, he makes these vibrations impress themselves on a sheet of metallic foil, and then reproduces from these impressions the sonorous vibrations which made them.

Faber solved the problem by reproducing the mechanical *causes* of the vibrations making voice and speech; Edison solved it by obtaining the mechanical *effects* of these vibrations. Faber reproduced the movements of our vocal organs; Edison reproduced the motions which the drum-skin of the ear has when this organ is acted on by the vibrations *caused* by the movements of the vocal organs.

Figs. 1 and 2 will render intelligible the construction of Mr. Edison's machine. A cylinder, F, turns on an axle which passes through the two standards, A and B. On one end of this axle is the crank, D; on the other the fly-wheel, E. The portion of this axle to the right of the cylinder has a screw-thread cut on it, which, working in a nut, A, causes the cylinder to move laterally when the crank is turned. On the surface of the cylinder is scored the same thread as on its axle. At F (shown in one-half scale in Fig. 2) is a plate of iron, A, about $\frac{1}{100}$ of an inch thick. This plate can be moved toward and from the cylinder by pushing in or pulling out the lever H G, which turns in an horizontal plane around the pin I.

The under side of this thin iron plate, A (Fig. 2), presses against short pieces of rubber tubing, X and X, which lie between the plate and a spring attached to E. The end of this spring carries a rounded steel point, P, which enters slightly between the threads scored on the cylinder C. The distance of this point, P, from the cylinder is regulated by a set-screw, S, against which abuts the lever, H G. Over the iron plate, A, is a disc of vulcanite, B B,

[1] The figures in this article are taken from "Sound, a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Sound, for the Use of Students of every Age." By Alfred M. Mayer. Vol. ii. of "Experimental Science Series for Beginners." (Now in press and soon to be published by D. Appleton and Co.)

with a hole in its centre. The under side of this disc nearly touches the plate A. Its upper surface is cut into a shallow, funnel-shaped cavity, leading to the opening in its centre.

To operate this machine, we first neatly coat the cylinder with a sheet of foil, made to adhere by coating the edges with shellac varnish, then we bring the point, P, to bear against this foil, so that, on turning the cylinder, it makes a depressed line, or furrow. The mouth is now

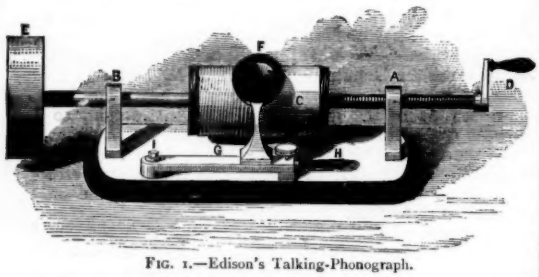


FIG. 1.—Edison's Talking-Phonograph.

placed close to the opening in the vulcanite disc, B B, and *the metal plate is talked to* while the cylinder is revolved with a uniform motion.

The plate, A, vibrates to the voice, and the point, P, indents the foil, impressing in it the varying numbers, amplitudes, and durations of these vibrations. If the vibrations given by the voice are those causing simple sounds, and are of a uniform, regular character, then similar, regular, undulating depressions are made in the

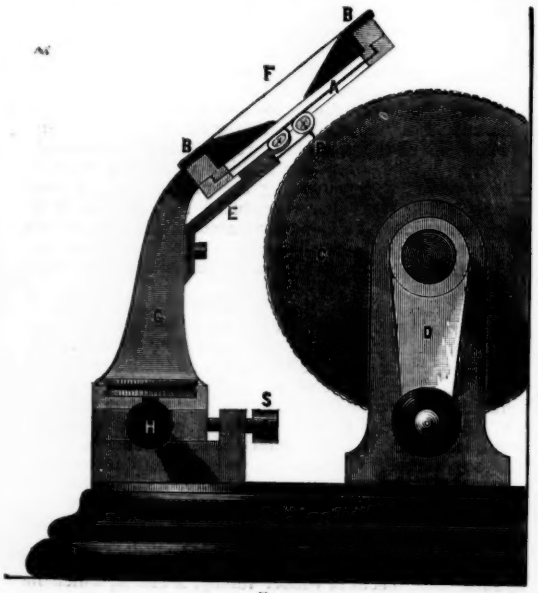


FIG. 2.

foil. If the vibrations are those causing complex and irregular sounds (like those of the voice in speaking), then, similarly, the depressions made in the foil are complex, having profiles like the curve, B, in Fig. 3. Thus the yielding and inelastic foil receives and *retains* the mechanical impressions of these vibrations with all their minute and subtile characteristics.

The permanent impressions of the vibrations of the voice are now made. It remains *to obtain from these impressions the aerial vibrations which made them.* Nothing is simpler. The plate A, with its point, P, is moved away from the cylinder by pulling toward you the lever, H G. Then the motion of the cylinder is reversed till you have brought opposite to the point P the beginning of the series of impressions which it has made on the foil. Now bring the point up to the cylinder; place against the vulcanite plate, B B, a large cone of paper or tin to re-enforce the sounds, and then steadily turn the crank, D. The elevations and depressions which have been made by the point, P, now pass under this point, and in so doing they cause it and the thin iron plate to make over again the precise vibrations which animated them when they made these impressions under the action of the voice. The consequence of this is, that the iron plate gives out the vibrations which previously fell upon it, and it *talks back to you what you said to it.*

By the following method we have just obtained several magnified traces on smoked glass of the contour, or profile, of the elevations and depressions made in the foil by the sonorous vibrations. On the under side of the shorter arm of a delicate lever is a point, made as nearly as possible like the point, P, under the thin iron plate, A. Cemented to the end of the longer arm of this lever is a pointed slip of thin copper-foil, which just touched the vertical surface of a smoked-glass plate. The point on the short arm of the lever rested in the furrow in which are the depressions and elevations made in the foil on the cylinder. Rotating the cylinder with a slow and uniform motion, while the plate of glass was slid along, the point of copper-foil scraped the lamp-black off the smoked-glass plate and traced on it the magnified profile of the depressions and elevations in the foil on the cylinder. I say expressly *elevations* as well as depressions in the foil, because, when the plate vibrates outward, the furrow in the foil often entirely disappears, and is always lessened in its depth by this outward motion of the point. One who has never made a special investigation of the character of the impressions on the phonograph, and forms his opinion from their appearance to his eye, might state that they are simply dots and dashes, like the marks on the filet of a Morse instrument

Another method of obtaining the profile of the impressions on the foil is to back it with an easily-fusible substance, and then, cutting through the middle of the furrows, we obtain a section, in which the edge of the foil presents to us the form of the elevations and depressions.

The instrument has been so short a time in my possession, that I have not had the leisure to make on it the careful and extended series of experiments which it deserves. I have, however, obtained several traces, and I have especially studied the characters of the trace of the sound of *bat*. As far as the few experiments warrant an expression of opinion, it seems that the profile of the impressions made on the phonograph and the contours of the flames of König, when vibrated by the same compound sound, bear a close resemblance.

In Fig. 3 we give on line A the appearance to the eye of the impressions on the foil, when the sound of *a* in *bat* is sung against the iron plate of the phonograph. B is the magnified profile of these impressions on the smoked glass obtained as described above. C gives the appearance of König's flame when the same sound is sung quite close to its membrane. I say expressly *quite close* to its membrane, for the form of the trace obtained from a point attached to a membrane vibrating under the influence of a compound sound depends on the *distance* of the source of the sound from the membrane, and the same compound sound will form an infinite number of different traces as we gradually increase the distance of its place of origin from the membrane; for, as you increase this distance, the waves of the components

of the compound sound are made to strike on the membrane at different periods of their swings.

For example, if the compound sound is formed of six harmonics, the removal of the source of the sonorous vibrations, from the membrane to a distance equal to $\frac{1}{4}$ of a wave-length of the first harmonic, will remove the second, third, fourth, fifth, and sixth harmonics to distances from the membrane equal respectively to $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, and $1\frac{1}{2}$ wave-lengths. The consequence evidently is, that the resultant wave-form is entirely changed by this motion of the source of the sound, though the sonorous sensation of the compound sound remains unchanged.

The above facts are readily proved experimentally by sending a constant compound sound into the cone of König's apparatus, while we gradually lengthen the tube between the cone and the membrane next to the flame. This is best done by the intervention of one tube sliding in another, like a trombone. These experiments I have recently made with entire success, and they explain the discussions which have arisen between different observers as to the composition of vocal and other composite sound, as analysed by means of König's vibrating flames.

These facts also show how futile it is for any one to hope to be able to *read* the impressions and traces of phonographs, for these traces will vary, not alone with the quality of the voices, but also with the differently-related times of starting of the harmonics of these voices, and with the different relative intensities of these harmonics.

It is necessary to give to the cylinder a very regular motion of rotation while it receives and reproduces the vibrations made in singing; for even slight irregularities in the velocity of the cylinder destroy the accuracy of the musical intervals, and cause the phonograph to sing falsetto. Even the reproducing of speech is greatly

FIG. 3.

improved by rotating the cylinder by mechanism which gives it uniformity of motion. If you make the machine talk by giving it a more rapid rotation than it had when you spoke to it, the pitch of its voice is raised; and by varying the velocity of the cylinder the machine may be made to speak the same sentence in a very bass voice, or in a voice of a pitch so high that its sounds are really elfish and entirely unnatural.

Recent experiments seem to show that the nearer the diaphragm A approaches to the construction of the drum-skin of the human ear by "damping" it, as the hammer-bone does the latter, the better does it record and repeat the sonorous vibrations; for the motion of a membrane thus damped is ruled alone by the aërial vibrations falling on it.

Mr. Edison has just sent me the following notes of the results of recent experiments:—

"That the size of the hole through which you speak has a great deal to do with the articulation. When words are spoken against the whole diaphragm, the hissing sounds, as in *shall*, *fleece*, *last*, are lost; whereas, by the use of a small hole provided with sharp edges, these words are reinforced and recorded. Also, teeth around the edge of a slot, instead of a round hole, give the hissing consonants clearer.

"That the best reading is obtained when the mouth-piece, BFB (Fig. 2), is covered with several thicknesses of cloth, so that the snapping noise on the foil is rendered less audible.

"I send you a sheet of copper-foil upon which I made records in Ansonia, Connecticut, that could be read 275 feet in the open air, and perhaps farther, if it had been tried."

Mr. Edison also states that impressions of sonorous vibrations have been made on a cylinder of soft Norway iron, and from these impressions have been reproduced the sonorous vibrations which made them.

ALFRED M. MAYER

THE OLD RED SANDSTONE OF WESTERN EUROPE[1]

PART I.

IN a historical introduction the author gives an outline of the progress of research into the history of the Old Red Sandstone of the British Area. This system is at present regarded as composed of three sub-divisions, Lower, Middle, and Upper, each characterised by a distinct suite of organic remains. From the absence of unequivocally marine fossils and from lithological characters, it has been inferred by Mr. Godwin Austen, Prof. Ramsay, Prof. Rupert Jones, as well as other observers, and is now very generally admitted that the Old Red Sandstone, as distinguished from the "Devonian" rocks, probably originated in inland sheets of water. The object of the present memoir was to endeavour to trace out in that geological system of deposits the changes of physical geography which took place over Western Europe during the interval between the close of the Upper Silurian and the beginning of the Carboniferous period.

After a sketch of the probable conditions of the region previous to the commencement of the Old Red Sandstone, the author proceeds to show how the shallowing Silurian sea was converted here and there into *salinas* or inland seas, by a series of subterranean movements which have left their indelible traces upon the upturned Silurian rocks. He divides his memoir into two parts, the first dealing with the Lower and the second with the Upper Old Red Sandstone. The present paper deals only with a portion of the first of these sections. It traces out the limits of the different basins in which the Old Red Sandstone of the British Islands were deposited, and for the sake of convenience as well as briefness of reference, proposes short geographical names for these basins, which are arranged as follows:—

[1] Abstract of paper by Prof. Geikie, F.R.S., read before the Royal Society of Edinburgh on April 1, 1878.

Area of the Basins.	Short reference names proposed to be applied to them.
1. The Old Red Sandstone tracts of the north of Scotland, embracing the region of the Moray Firth, Caithness, the Orkney Islands, the mainland of Shetland, and perhaps part of the south-western coast of Norway.	Lake Orcadie.
2. The central valley of Scotland between the Highlands on the north and the Silurian uplands on the south, including the basin of the Firth of Clyde, and ranging across the north of Ireland to the high grounds of Donegal.	Lake Caledonia.
3. A portion of the south-east of Scotland and north of England extending from near St. Abb's Head to the head of Liddesdale, and including the area of the Cheviot Hills.	Lake Cheviot.
4. A district in the north of Argyllshire extending from the mouth of the Sound of Mull to Loch Awe, and perhaps up into the southern part of the Great Glen.	Lake Lorne.
5. The Old Red Sandstone region of Wales and the border counties of England, bounded on the north and west by the older palæozoic hills, the eastern and southern limits being unknown.	The Welsh Lake.

Lake Orcadie.—After describing the limits of this basin, and giving a sketch of the labours of previous observers in the Old Red Sandstone tracts of the north of Scotland, the author proceeds to examine the evidence for the threefold arrangement of the Old Red Sandstone proposed by Murchison. He shows that nowhere are the three groups, Lower, Middle, and Upper, found in consecutive order; that this so-called "Middle" division occurs only in the north of Scotland, where it lies unconformably upon the older palæozoic rocks, and is itself unconformably overlaid by the Upper Old Red Sandstone, thus occupying a position exactly similar to that of the Lower Old Red Sandstone on the southern side of the Highlands. He further points out that while some species of fishes are common to the Old Red Sandstone on the two sides of the Highland barrier, the lithological differences between the deposits of the two areas are so great as to make it evident that the rocks were laid down in distinct basins and consequently that the fauna of each basin might be expected to be more or less peculiar, as in many analogous cases at the present day. As evidence that adjacent areas in the time of the Lower Old Red Sandstone were strongly marked off from each other in their faunas, reference is made to the contrast between the fishes and crustaceans of the Welsh region and those of Lanarkshire and Forfarshire, not a single species being common to the two countries though some of the genera are. Reasons are then given why the argument used by Murchison from the occurrence of many of the Scottish ichthyolites in Russia could not be regarded as establishing the existence of a "Middle" division of the Old Red Sandstone.

The conclusion arrived at by the author is that the Caithness flags or "Middle Old Red Sandstone" are probably the general equivalents of the Lower Old Red Sandstone of other regions, and that this system consists in Britain of two well-marked divisions only—a Lower, which graduates in some places into the Upper Silurian rocks and is separated by an unconformability from an Upper which in many districts passes up into the base of the Carboniferous system.

The various districts into which the area embraced under the term Lake Orcadie may be divided are then described *seriatim*. The detailed structure of Caithness has been worked out by the author (partly with the co-operation of his colleagues in the Geological Survey, Mr. B. N. Peach and Mr. John Horne) as affording the most complete sections of the Old Red Sandstone in the North of Scotland. Arranged in descending order, the various stratigraphical zones stand as in the subjoined table:—

	Thickness in feet.
9. John O'Groats Red Sandstone, Flagstones, and impure Limestones and Shales	2000
8. Huna Flagstones, Shales, and Limestones ...	1000
7. Gill's Bay Red Sandstones	400
6. Thurso or northern group of Flagstones, Shales, and Limestones	5000
5. Wick or eastern group of Flagstones, Shales, and Limestones passing down into Red Shales and Sandstones	5000
4. Dull Red Sandstones, Red Shales, and fine Conglomerates...	2000
3. Brecciated Conglomerates	300
2. Badbea Red Sandstones and Shales or Clays..	450
1. Coarse basement Conglomerates	50
	16,200 ft.

From the four lowest sub-divisions no fossils have yet been obtained. The flagstones have yielded to Mr. C. W. Peach, and other observers many land plants (some of which resemble forms described by Dawson from the Gaspé sandstones) as well as *Estheria membranacea*, *Pterygotus*, sp., and many ichthyolites. Availing himself of the list of localities furnished to him by Mr. Peach (to whom he cordially acknowledges his obligations) with the species of fish found at each, the author has constructed a table of the vertical distribution of the fossil fishes in Caithness. Some of the species range through almost the entire succession of beds. Some, however, are either peculiar to or very characteristic of one sub-division. Thus *Osteolepis arenatus* and *Dipterus Valenciennesi*, are not noted except from the group No. 5. In the Thurso and the higher flagstones (Nos. 5, 8, and 9) *Acanthodes*, *Parexus*, *Cheiracanthus*, *Diplacanthus*, *Pterichthys*, *Tristichopterus*, and *Holoptychius*—genera absent from the Wick beds—are found in greater or less abundance. These strata are further marked by peculiar species of genera which likewise occur among the older flagstones, as *Coccosteus pusillus* and *Osteolepis microlepidotus*.

The Orkney Islands are assigned to the higher sub-divisions of the flagstone series, the protruding ridge of granite and gneiss which rises at Stromness and Gremsa being merely an indication of the irregular surface, on which the deposits of Lake Orcadie were accumulated, and of the slow progressive subsidence of the area. The fossils, for which these islands have long been famous, include most of those of the upper groups of Caithness, with the addition of others which have been regarded as distinct. In the determination of these fossils much skill is required to discriminate between the accidental differences of aspect resulting from the condition of fossilisation. The Orkney fishes, for instance, are preserved as black jet-like impressions which, often very perfect when first removed from the quarry, are apt to scale off, leaving in each case only an amorphous layer which, though it retains the contour of the fish, shows little or no trace of structure. On the shores of the Moray Firth, on the other hand, the organisms have been inclosed within calcareous nodules; their colours are sometimes brilliant, and their scales, plates, fins, and bones, are often admirably preserved and remain unchanged in the Museum. Want of experience in these different modes of preservation may have led to a reduplication of species, especially in the case of the Orkney and Moray Firth fishes. Among the most interesting Orkney fossils is a portion

of a *Pterygotus* (recognised by Dr. H. Woodward), now in the British Museum. The occurrence there of this characteristically Upper Silurian and Lower Old Red Sandstone genus supports the view contended for in this paper as to the true horizon of the Orkney and Caithness flagstones.

The Shetland Islands contain a portion of the shoreline of Lake Orcadie with its conglomerates and sandstones and the flagstones and shales of deeper water. Among these strata the Caithness *Estheria* occurs, with abundant stems and roots of large calamite-like plants with well-marked flutings but without observable joints. Some ichthyolites of the Caithness type are said to have been found in Bressay. The general lithological characters are quite those of the sandy parts of the Orkney and Caithness groups. On the west side of the mainland of Shetland interesting evidence occurs to show the existence of volcanic action contemporaneous with the accumulation of the Old Red Sandstone. Beds of amygdaloidal lavas and bands of tuff occur among the sandstones, the whole being pierced by masses of pink felsite.

The south-western and southern margin of this great northern basin of the Old Red Sandstone can still be traced nearly continuously from the confines of Caithness to the borders of Aberdeenshire, its position being marked by a zone of littoral conglomerates. Beyond the edge of that zone, however, there occur some interesting outliers which in some cases may represent long fjord-like indentations of the coast line; in others may mark what were really independent basins lying at the base of the Grampian Mountains. The author points out that probably most of the difficulty which has hitherto been experienced in understanding the sequence of beds along the southern shores of the Moray Firth and their parallelism with those of Caithness and Orkney is not to be attributed to the amount of detritus covering the country, but rather to the fact which has not heretofore been observed that the Upper Old Red Sandstone with *Holoptychius* and *Pterichthys major* really overlap unconformably upon the older nodular clays and conglomerates with *Coccasteus*, *Cheirolepis*, &c. This relation could be satisfactorily determined in Morayshire, and was now being worked out by Mr. John Horne in the course of the Geological Survey. The author traces in great detail from the Spey into Sutherlandshire, the development of the lower sandstone conglomerates and clays, which have been regarded as equivalents of the Caithness flagstones. He thinks that in no sense can this comparatively thin group of rocks (seldom 1,400 feet in depth) be regarded as a mere southward attenuation of the great Caithness series, as suggested by Murchison, for that neither lithologically nor palæontologically can that view be sustained. He has been led to the conclusion that the whole of these rocks from the borders of Sutherlandshire to those of Aberdeenshire represent only the higher portions of the great Caithness series, and that they were formed during a gradual depression of the ancient high grounds whereby the waters of Lake Orcadie were allowed to creep southward over the descending land. This movement is indicated by the character of the strata, and that it took place about the time of deposit of the later flagstones of Caithness is shown by the occurrence of the fossils of that division in the nodules, flags, and clays of the Moray Firth region, while those of the Lower division are absent.

Allusion is likewise made to the discovery of two localities where contemporaneous volcanic action has recently been observed in the Moray Firth area, the whole of the basin of Lake Orcadie being otherwise remarkably free from any trace of such action except on the northern margin in Shetland. The history of the area embraced by Lake Caledonia will form the subject of the next paper.

NOTES

We regret to have to announce the death of Dr. F. Brüggemann. Dr. Brüggeman was a native of Bremen and studied at Jena, where he was for several years assistant to Prof. Haeckel. His earliest publications were on entomological subjects, but later he published an account of the Amphibians and Reptiles of Bremen. He was especially interested in ornithology, and amongst other papers on this subject published two on the Birds of South-Eastern and Central Borneo (*Abhand. d. naturw. Vereins zu Bremen*, Bd. v. u. vi.). On the recommendation of Prof. Haeckel, Dr. Brüggemann was engaged last year by Dr. Günther to arrange and catalogue the collection of corals in the British Museum. Whilst in the midst of this undertaking he died suddenly at his lodgings on the night of Saturday last of hæmorrhage from the lungs. He had already named 1,500 species of corals in the collection, and had published two papers on undescribed forms in the *Annals and Magazine of Natural History*. He had in hand a revised list of all species of recent corals hitherto described, which was in an advanced state and which he had intended to have published. He was of an extremely amiable disposition and his loss is deeply regretted in London by the staff of the British Museum and other naturalists with whom he was acquainted. He was under thirty years of age at the time of his death.

On Thursday last the members of the General Council summoned to deliberate upon the improvements required in the organisation of the Paris Observatory waited upon M. Bardoux, the Minister of Public Instruction. They insisted upon the necessity of continuing the existing connection between astronomy and meteorology in accordance with the principles established by M. Leverrier himself, and developed the reasons which had led the majority to pass a resolution in favour of that system. A number of eminent scientific men had interviews with M. Bardoux, and have made a strong impression upon his mind. M. Bardoux has ordered all the letters from a number of departmental meteorological commissions to be summarised, and it has been found that not a single one has urged the disconnection of the two departments. We are in a position to state that according to every probability, during the present month, the Academy of Sciences and the new Council of the Observatory will be summoned to present each two candidates, between whom the Minister will exert his right of selection according to the provisions of the newly-published decree.

Captain Feilden, R.A., naturalist to the late British Expedition to the Arctic Regions, and Mr. De Rance, of H.M. Geological Survey, are announced to read a paper on the Geology of the Northern Lands visited, at the next meeting of the Geological Society of London, at which Mr. Etheridge will present a detailed report of the palæontology of the same area. We understand that the British Museum will probably be the destination of the very numerous collection of geological specimens made by Capt. Feilden, Dr. Coppinger, and other officers of the expedition.

M. Belgrand, Director of the Paris Sewers and Waterworks, died suddenly on the 8th inst. in his sixty-eighth year. To him Paris owes its network of sewers and its supply of water from the Dhuys, the Vanne, and the Somme Soude. He also devised the system of hydrological observations, by which floods are foreseen. As a connoisseur of water he is said to have had no rival.

It is stated that Prof. H. J. S. Smith, F.R.S., is to be a candidate for the representation of Oxford University in Parliament.

The coloured spherules discovered by M. Hannover in the cones of the retina of many birds are known to have three colours: a yellowish green, an orange yellow, and an intense

ruby red. Lately, M. Capranica affirmed the identity of these different colouring matters and their close relation to visual red and the widely expanded lutein (found in the yolk of egg, adipose tissue, corpora lutea, the ovary of mammalia, &c.), and he cited various reactions as proving this relation. M. Kuhne has lately, in the *Centralblatt für die Medicin. Wiss.*, opposed this view; he has succeeded easily in isolating the three colouring matters after they were freed from fat, and he affirms that as regards spectroscopic behaviour, reaction, and solubility, they may be clearly distinguished.

THE French Academy had proposed for the prize of eloquence in 1877 the *éloge* of Buffon, the celebrated naturalist, and not less than seventeen memoirs were presented. Two were found so excellent that in opposition to the traditions of the Academy, they were declared *ex æquo*, as having obtained the premium. When the sealed envelopes containing the names of the authors were opened, it was found that one of them had died before he had quite revised his work. The name of this posthumous laureate is M. Narcisse Michaud. M. Dumas has written a letter of sympathy and regret to the family in the name of the Academy.

M. DE WATTEVILLE, one of the chief secretaries of the French Minister of Public Instruction, has lately submitted a plan for the formation of a large scientific committee in Paris, which shall stand in direct communication with all existing learned societies. The project will be put into execution during the present month, and M. Bardoux, the Minister of Public Instruction, will be the first president of the committee.

ON April 4 was held at the Tuileries a meeting of the several committees which had been appointed in order to organise the series of congresses intended to take place in Paris during the Universal Exhibition. After having returned thanks to his numerous subordinates for their exertions, the Minister for Public Works read a list of eleven congresses which are completely organised, viz.:—1. Agriculture. 2. Metrical and monetary, for the adoption of a universal system. 3. Special congress for determining a universal measure of threads of every description used in textile fabrics. 4. For the protection of literary, artistic, and industrial property, patents, &c., &c. 5. For provident institutions, life, fire, agriculture, &c., insurances. 6. Philological. 7. A congress inaugurated by European economists. 8. Meteorological. 9. The French Alpine Club will call a congress of every similar institution. 10. Public hygiene. 11. A congress for the international regulation of measures against the propagation of epizootics. Other congresses are in preparation. The several regulations will be published very shortly, mentioning the dates, the space of time allotted to them, the several programmes, the places of meeting, the conditions of admission, and the composition of initiative commissions.

HERR ACHENBACH, the Prussian Minister of Commerce, has lately issued an order that during the Paris Exhibition arrangements shall be made at the Berlin School of Mines to put at the service of those desiring to study the mineral wealth of the kingdom, all possible cartographical and literary requisites, as well as information as to the best means of reaching all points of interest in the mining regions; this disposition is made more especially for the benefit of American scientific visitors in recognition of the courtesies extended by them in this direction two years ago.

A GUIDE for the approaching Exhibition at Paris has just been published under the title "Guide de l'Exposition Universelle et de la Ville de Paris." (Paris: Bureau de la Publicité.) It contains no less than fifty-four maps and plans.

THE Institute of Naval Architects commences its annual session to-day; the meetings will be continued to-morrow and Saturday. A large number of papers on subjects of great importance are down for reading.

THE agents of the Paris Acclimatisation Society are engaged in organising, at Marseilles, a zoological garden which will be considered as an annexe to the Parisian establishment. A certain number of animals have already arrived but have not yet been placed in the cages which are being built for them.

A PAPER on "State Aid to Music at Home and Abroad" was read by Mr. Alan S. Cole, at the Society of Arts on Wednesday evening, March 27. Allusion was made to the constitution of foreign Conservatoires, which, to a considerable extent, depend upon the support given to them by the governments of the countries in which they are established. Government support gives an element of stability to these foreign Conservatoires, and Mr. Cole endeavoured to show that in the United Kingdom there is an absence of stability in respect of the different music schools which exist. Our academies and schools of music have been founded by private enterprise, and their existence, depending upon the fluctuations of subscriptions and amateur fee-paying students, seems to have no guarantee of permanence. In regard to freely established classes for promoting science and art, the prospect of their becoming permanent is assisted by the offer of national payments for ascertained results of instruction. In elementary day schools the education department makes a payment of one shilling per child who attends a school where singing is taught. These shilling payments amount to 96,000*l.* a year. As, however, the Inspector of Music, Mr. John Hullah, reports that the musical proficiency of the children is bad, it may be inferred that not only is the instruction of the children in music bad, but the payment also of so large a sum as 96,000*l.* per annum is of little use in securing for national benefit an adequate return. The supply of duly qualified teachers in the art and science of music may probably tend to diminish the disproportion between the annual expenditure and the insufficient return of results in musical instruction. Accepting the general features common to Conservatoires abroad as the outlines for similar institutions at home, Mr. Cole called attention to the Royal Academy of Music and to the New National Training School for Music at Kensington. The Royal Academy is not a Conservatoire according to the definition given. The constitution of the National Training School is similar to that of the chief Conservatoires. The tendency of individual or private enterprise seems to direct itself towards the training of singers and peformers; and it was stated that the Kensington School was at present training nearly a hundred scholars of this class. The duty of the Government is to provide qualified teachers, the results of whose instruction shall be of value to the country at large, and therefore properly to be paid for out of the exchequer. The form of State aid which it was suggested might be given was the payment of the fees of instruction of a certain number of students whose aim is to be teachers in elementary schools, in local classes, and music schools throughout the country. Such payment of fees would be made to that academy or training school whose proved methods of instruction seemed to be the best, and the work promoted by this kind of State aid would not compete with that part of national culture which is at present dependent upon the support given according to the whims of the givers, and therefore of an uncertain, spasmodic, unbusiness-like character.

M. CAZIN, the eminent French physicist, whose premature death we noticed a few months since, left a manuscript on Spectrum Analysis. This has just been published by Gauthier Villars in his "Actualités Scientifiques."

THE Annual Meeting of the Cumberland Association for the Advancement of Literature and Science will be held at Cockermouth on Easter Monday and Tuesday. A varied and interesting

programme is arranged for the two days, one of the items being a lecture by Sir George Airy on "The Probable Condition of the Interior of the Earth."

FOR Easter Monday and following day the Geologists' Association have arranged what promises to be an interesting excursion to Chipping Norton. Provincial field societies are now also issuing programmes of their summer excursions; the Manchester Field Naturalists and the Leeds Naturalists have sent us well-arranged programmes of this kind.

EXCAVATIONS in the neighbourhood of Merten, in Lorraine, have uncovered the remains of an old Roman temple, and brought to light a variety of weapons, busts, coins, &c. The indications all point to the existence of a large settlement here under the Roman rule, and arrangements have been made for a series of widely extended excavations.

THE archæologists of Rome are busied over the latest discovery, the uncovering of a cellar containing a thousand vessels for various commercial purposes, two hundred of which are covered with inscriptions throwing no small light on the business terms of the ancient Romans.

IN the course of a report, which has just been published by order of the Inspector-General of Maritime Customs in China, Dr. F. Wong gives us some curious particulars respecting a strange remedial agent employed by the Chinese in cases of *Cynanche Tonsillaris*. The disease they term *Ngo-how*, or "Goose-throat," and the remedy in question is called *How-tsao*, a soft stone not unlike biliary calculus in appearance. It is expensive, being worth twenty times its weight in silver, and is said to come from Siam. Twenty or thirty grains of this in powder, taken in water, is thought to be very efficacious. Dr. Wong mentions having seen a case where this remedy was given, and where it certainly appeared effective, after gargles and astringents had been applied in vain. The specimens of the stone which have come under his notice appear like animal concretions, and are of various sizes, some being smaller than pigeons' eggs, while others are as large as hens' eggs. The story goes that, when a monkey is wounded, the animal, from its natural instinct, picks out the proper medicinal herbs, masticates and applies them to the wound, so that successive layers are in this way laid on so as to form a mass. In time the wound heals, and the lump of dried herbs falls off; it is then picked up by the Siamese, found by them to possess peculiar virtues, and sent in small quantities to China as a drug.

NEWS from Berlin states that Prof. Mommsen has again started upon a scientific expedition to the south of Italy, from which he intends to return to Berlin at the end of May.

IN the south of France no rain or snow has fallen since the beginning of the winter, and the prevailing drought resulting from this peculiar absence of atmospheric moisture has well-nigh assumed the proportions of a real catastrophe. The authorities have been obliged to take in hand the distribution of drinking water to the inhabitants. Between Marseilles and the Italian frontier certain railway stations are completely without water, and waggon-cisterns had to be constructed which are kept filled by water brought by train. The soil in the district is so hard that all agricultural work is impossible, and the crops are, of course, in a most miserable condition.

FROM Leipzig and its vicinity heavy rains are reported causing severe inundations in that neighbourhood.

DR. A. HARTMANN describes in the *Proceedings* of the Berlin Physiological Society for the present year, a new application of the telephone for the purpose of testing the hearing. It rests upon the fact that when the magnet of the receiving instrument is excited by a galvanic stream, the intensity of the tone transmitted can be altered at will by the introduction of various resistances or of Du Bois-Reymond's compensator into the circuit. By this means it is easy to measure comparatively in different persons the limits of hearing, by applying the telephone to the ear, and noticing the amount of resistance necessary in order to extinguish the same sound.

THE American Chemical Society closes its second year with a membership of 300. Its *Transactions*, instead of appearing at irregular intervals, are to be published twice a month, and efforts are being made to concentrate in them all that America produces in the line of chemical research. The Society has chosen Prof. Johnson, the familiar authority on agricultural chemistry, for its president during 1878, and has elected to honorary membership Professors Frankland and Williamson, of London, Bunsen and Wöhler of Germany, Berthelot of Paris, Boutlerow of St. Petersburg, and Cannizzaro of Rome.

AN earthquake was felt at Liesthal, in the canton of Bâle during the night of March 28–29. This phenomenon was probably connected with another commotion which was registered at Strasburg Observatory by Winnecke, and was observed on March 29 at 8h. 52m. 27s. in the morning. The duration of the commotion was only $\frac{1}{8}$s., and would have escaped notice if a registering apparatus had not been kept at the observatory. A violent earthquake was felt at Kaltenbrunn, in the Kaunser Valley (Tyrol) on March 16 at 5 A.M.

MR. A. O. THORLACIUS, the observer for the Scottish Meteorological Society at Stykkisholm, in the north-west of Iceland, reports the occurrence, on March 4, of the severest thunderstorm ever experienced in that part of Iceland. Thunder and lightning continued without interruption from 5.30 A.M. to 8 A.M., accompanied at intervals with rain and hail. For the past thirty-three years, during which Mr. Thorlacius has observed, nearly all the thunderstorms have occurred during the winter months. At 7 A.M. a very fine meteor passed over the village of Stykkisholm and exploded into innumerable fragments over the harbour, unaccompanied, however, with any audible report, and shortly after another fine meteor passed over the village and disappeared without being observed to explode. It is added that this is the first time such meteors have been observed by any one at Stykkisholm.

WITH regard to the fact stated by M. Forel, that frequently during distinct shocks of earthquake, the lakes show neither waves nor *seiches*, while at other times shocks produce large movements, M. De Rossi writes to *La Nature*, from Rome, that the lakes probably act according to the law of pendulums. Thus in Italy shocks of earthquake have frequently occurred without the pendulum seismograph showing any sign of movement, whereas, again, the pendulum may swing violently without the shock being perceived by any one. M. De Rossi has, with others, experienced a distinct shock of earthquake, and on immediately examining with a microscope eight pendulums of different lengths, could not detect the slightest motion. The fact evidently depends, he says, on the relation between the length of the pendulum and the rapidity of the earth-vibrations. When the seismic wave is *synchronous* with the natural oscillation of the pendulum, the latter enters into motion; when it is *dissynchronous*, the pendulum refuses to move.

IT will be seen from our advertising columns, that pending the erection of the permanent buildings of the Channel Islands' Zoological Station, St. Helier's, Jersey, arrangements have been made for placing private rooms with tables and apparatus at the disposal of a limited number of naturalists and students, with every assistance in obtaining subjects for investigation.

THE additions to the Zoological Society's Gardens during the past week include two Persian Gazelles (*Gazella subgutterosa*) from Persia, presented by Mr. R. W. Inglis; a Macaque

Monkey (*Macacus cynomolgus*) from India, presented by Mr. Francis Pym; a Common Squirrel (*Sciurus vulgaris*), European, presented by Madame Hante; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Capt. F. Ayling; a Pudu Deer (*Cervus humilis*), a Naked-eared Deer (*Cervus gymnotis*) from Chili, a Maned Goose (*Bernicla jubata*) from Australia, purchased; an Egyptian Gazelle (*Gazella dorcas*) from Egypt, deposited; a Frazer's Squirrel (*Sciurus fraseri*) from Ecuador, a Black Sternothere (*Sternothærus niger*) from West Africa, received in exchange.

UNDERGROUND TEMPERATURE[1]

OBSERVATIONS on a very elaborate scale have been received from the important mining district of Schemnitz, in Hungary. A request for observations was sent by the Secretary, in 1873, to the Imperial School of Forests and Mines at Schemnitz, and on the receipt of two thermometers a Committee was formed to plan and carry out observations. The leading part in the observations has been taken by Dr. Otto Schwartz, Professor of Physics and Mathematics, who has furnished an elaborate report of the results obtained. This is accompanied by a geological report drawn up by Prof. Gustav von Liszkay and by a geological map with plans and sections of the mines.

The two thermometers sent being deemed insufficient for the numerous observations which were contemplated, twenty-five large thermometers were ordered from a local maker (T. T. Greiner), and the ten best of these, after being minutely compared with one of the two thermometers sent—which was non-registering and had a Kew certificate—were devoted to the observations. Three of them were divided to tenths and the others to fifths of a degree Centigrade, and all had bulbs of thick glass to ensure slowness of action. They were found not to change their indications during the time requisite for an observation.

The observations were for the most part taken by boring a hole in the rock to a depth in the earlier observations of ·422, and in the later ones of ·79 of a metre, then filling the hole with water, and after leaving it in some cases for a few hours, in others for several days, to plunge a thermometer to the bottom of the hole, and after thirty or forty-five minutes take it out and read it. The tenths of a degree were read first, and there was time for this to be done before the reading changed. As a rule three observations were taken in each gallery, two of them in bore-holes to give the temperature of the rock, and the third in the air of the gallery at an intermediate position. Pyrites and also decaying timber were avoided as being known to generate heat, and as far as possible currents of air and the neighbourhood of shafts were avoided also.

A table, which forms part of Dr. Schwartz's report, contains observations made in no fewer than thirty-eight galleries. Besides the temperatures, it gives the depth of the place of observation beneath the shaft-mouth and the height of the latter above sea-level. Dr. Schwartz takes exception to a few of the observations in the table, as being vitiated by the presence of pyrites or by currents of air.

All the galleries mentioned in the table are classified according to the shafts with which they are connected, and there are for the most part six of these galleries to each shaft. In the final reductions, Dr. Schwartz compares the temperature in the deepest gallery of each shaft with the assumed mean annual temperature of the ground at the shaft-mouth. For determining this latter element the following data are employed.

The mean temperature of the air at the School of Mines, from twenty years' observation, is 7°·2 C. at the height of 612·6 metres above sea-level. The shaft-mouths are at heights of from 498 to 763 metres above sea-level, and it is assumed that the temperature of the air falls 1° C. for 100 metres of elevation. It is further assumed that the mean temperature one metre deep in the soil is, in these particular localities, 1° C. higher than the mean temperature of the air. The reasons given for this last assumption may be thus summarised :—

1. Observations in various localities show that in sandy soils the excess in question amounts on the average to about half a degree Centigrade.

2. In this locality the surface is a compact rock which is highly heated by the sun in summer and is protected from radiation by a covering of snow in winter; and the conformation of the hills in the neighbourhood is such as to give protection against the prevailing winds. Hence the excess is probably greater here than in most places, and may fairly be assumed to be double of the above average.

Omitting one shaft (Franz shaft), in which, owing to the presence of pyrites, the temperatures are abnormal, the following are the principal results :—

	Depth in metres.	Increase of temp. Cent.	Quotient, or metres per 1° C.	Feet per 1° F.
Elizabeth shaft	417	8·5	49·1	89·5
Maximilian ,, ...	253	6·4	39·5	72·0
Amalia ,, ...	285	8·1	35·2	64·2
Stefan ,, ...	218	7·2	30·3	55·2
Siglisberg ,, ...	414	8·1	51·1	93·2
Sums, &c.	1587	38·3	41·4	75·5

The best mode of combining the results from these five shafts is indicated in the last line of the above table, where the sum of the depths is compared with the sum of the increments of temperature. We have thus a total increase of 38°·3 C. in 1,587 m.; which is at the rate of 1° C. in 41·4 m., or 1° F. in 75·5 feet.

As these results depend on an assumption regarding the surface-temperature, it seems desirable to check them by a comparison of actual observations, namely, by comparing the deepest with the shallowest observation in each mine. We thus obtain the following results :—

	Difference of depth, metres.	Difference of temperature, Cent.	Quotient metres per deg. Cent.	Feet per deg. Fahr.
Elizabeth shaft	145·2	4·6	31·6	57·6
Maximilian ,, ...	191·6	3·9	49·1	89·5
Amalia ,, ...	228·2	5·1	44·8	81·7
Stefan ,, ...	82·0	4·7	17·4	31·7
Siglisberg ,, ...	400·3	8·0	50·0	91·2
Sums, &c.	1047·3	26·3	39·8	72·5

Combining these results in the same manner as the others, we have a total difference of 26°·3 C. in 1047·3 metres, which is at the rate of 1° C. in 39·8 metres, or 1° F. in 72·5 feet.

The near agreement of this result with that obtained from comparison with the assumed surface-temperature is very satisfactory. The mean of the two would be 1° F. in 74 feet.

The rocks consist, for the most part, of trachyte and greenstone.

Dr. Schwartz concludes his report with the suggestion that the heat developed by the decomposition of pyrites and galena in seams which are not altogether air-tight and water-tight, may possibly be utilised as a guide to the whereabouts of metallic lodes; and that "we shall thus obtain, by means of the thermometer, scientific information which the ancients sought by means of the divining-rod."

Thanks are due to M. Antoine Péch, Ministerial Councillor, and Director of the Mines, and to Herr Edouard Pöschl, Director of the School, for energetic co-operation in this extensive and valuable series of observations.

Mr. Lebour, having been requested to supplement the above *résumé* of the Schemnitz observations by an account of the connection (if any) between the geological and thermal conditions of the several mines, as indicated by a comparison of the reports of Dr. Schwartz, and Prof. von Liszkay, remarks :—

"The rock at all the mines except Franzschacht is gree

[1] Report of the British Association Committee on Underground Temperature, by Prof. Everett.

hornblende-andesite (*in German* Grünstein-trachyt), a compact fine-grained crystalline, more or less vitreous rock, containing crystals of oligoclase and hornblende, but *no quartz or sanidine*. This rock is a good heat-conductor, with a conductivity probably nearly approaching that of 'Calton trap rock.'

"The Franzschacht is sunk in rhyolite (a highly siliceous vitreous trachyte), a rock, the conductivity of which would presumably be nearly the same as that of hornblende-andesite, probably a little greater. Elements of temperature-disturbance are, however, present in the form of thermal springs, and, possibly, in the proximity of a basaltic cone. This last element of disturbance is, I should imagine, a very doubtful one indeed, although Councillor A. Péch appears to think it of importance. The rate of increase, as deduced from observations in the rhyolite here, was 1° C. for 40·55m., or about 1° F. for 74 feet.

"The report brings out strongly the important variations of rock-temperature which may be, and are occasionally, generated by the decomposition of metallic sulphides, a point which I think is here prominently mentioned for the first time."

At the request of Mr. Lebour, observations have been taken by Mr. Matthew Heckels, Manager of Boldon Colliery, between Newcastle and Sunderland, in holes bored upwards to a distance of ten feet from some of the deepest seams.

The mine is described as "perfectly dry," and those parts of it in which the observations were made are quite free from currents of air. The surface of the ground is tolerably level, and is ninety-seven feet above Trinity high-water mark.

Hole No. 1 is bored up from the roof of the Bensham seam. The thermometer—one of the new slow-action instruments, not self-registering—was placed at the end of the hole (so as to be ten feet within the rock) and protected by air-tight plugging. The surrounding strata consist of arenaceous shale, known as "grey metal." The distance of the thermometer from the surface of the ground overhead was 1,365 feet.

The hole had been standing idle for some time when the thermometer was inserted, April 5, 1876. The first reading was taken April 26, and was 75°, the surrounding air being at 75½°, and almost stagnant. The readings were repeated during four consecutive weeks, without change of the indications.

Hole No. 2 is in the same vertical with No. 1, and is bored up (also to the height of ten feet) from a deeper seam—the Hutton seam. The same thermometer was employed, and in the same manner. The surrounding strata consist of a close, compact sandstone known as "hard post." The distance of the thermometer from the surface of the ground overhead was 1,514 feet. Immediately after the drilling of the hole, June 6, 1876, the thermometer was inserted, and on July 4 the first reading was taken, namely, 81°. On July 24 it had fallen to 79½°, and on August 1 to 79°. Readings taken on August 15 and 29 and September 1 also showed 79°, the surrounding air having never altered from the fixed temperature, 78½°. It would therefore appear that the first observation in this hole was 2° too high, owing to the remains of the heat generated in boring, notwithstanding the lapse of four weeks which had intervened. Four readings have since been taken at regular intervals, ending with July, 1877, and the same temperature, 79°, continues to be shown.

Assuming 48° as the mean annual temperature of the surface, we have the following data for calculating the rate of increase downwards:—

Surface	48°
1,365 feet	75°
1,514 feet	79°

For the interval of 149 feet between the two holes we have an increase of 4° F., which is at the rate of 1° F. in 37 feet.

For the whole depth of 1,514 feet from the surface to the lower hole we have an increase of 31°, which is at the rate of 1° F. in 49 feet.

In explanation of the length of time required for the heat of boring to disappear in the second hole, Mr. Heckels remarks that "it required two men sixteen hours with a hand-boring machine to drill this hole, so hard is the stratum." He further says: "The tool by which this hole was bored, on being drawn out, was too hot to allow it being touched with the hand, so that the temperature of the hole, on being finished, must have been considerable; and no doubt it would be when we consider the immense pressure required to bore holes in such strata as this." With respect to the permanent temperature, 78½°, of the surrounding air, Mr. Heckels remarks: "The air of this district is almost stagnant, and what circulation there is will have travelled a distance of three miles underground; and hence it may be expected to be itself pretty near the temperature of the rocks through which it is circulating."

The dryness of the mine, the absence of currents of air, and the great depth render these observations extremely valuable for the purpose which the Committee have in view, and their best thanks are due to Mr. Heckels and the proprietors of the colliery for the trouble and expense which have been incurred in procuring them. Observations will shortly be taken in another bore in the same colliery.

During the past year the first observations have been received from India. They were taken by Mr. H. B. Medlicott, M.A., of the Geological Survey, in bores made in search of coal, and have been published by him in the "Records of the Geological Survey of India," vol. x., part 1. The instrument employed was a "protected Negretti" thermometer sent by the secretary of this Committee to Dr. Oldham, the director of the Survey. A Casella-Miller thermometer was used to check the observations, but was found much less sensitive and steady, and its readings, though placed on record, are therefore left out of account by Mr. Medlicott in his reductions.

The observations were taken in three bores, at places named Khappa, Manegaon, and Moran; but the observations at Moran were made only four hours after the boring tool had been at work, and the Khappa bore exhibited a strong bubbling, besides other marks of convection. The results obtained at these two bores must therefore be discarded; but in the Manegaon bore everything was favourable for satisfactory observation. "It was closed on April 24, 1875, so that it had been at rest for twenty months. There is only one guide-pipe ten feet long at the top of the bore, there never having been any pressure of water in the hole. The position is low, and the water had always stood at or near the mouth of the tube. There was no difficulty in removing the plug. The very equable series of temperatures is the natural result of these conditions. The observations were taken in the evening of the 5th and morning of the 6th of December. At 5 P.M. the air-temperature was 72°; at 8 P.M., 59°; at 8 A.M., 65°; at 11 A.M., 84°. The slight decrease of temperature in the top readings is a good proof of the perfectly tranquil conditions of observation. It is no doubt due to the excess of summer heat not yet abstracted; and it is apparent that that influence reaches to a considerable depth—quite to sixty feet." The following are the observations:—

Depth, feet.	Temperature, Fahr.	Depth, feet.	Temperature, Fahr.
10	81·15	150	82·7
20	81·1	200	83·3
40	81·0	250	84·0
60	81·0	300	84·65
80	81·3	310	84·70
100	81·8		

This last observation was in mud, the hole, which had originally a depth of 420 feet, having silted up to such an extent that 310 feet was the lowest depth attainable. The increase from 60 feet downwards is remarkably uniform, and the whole increase from this depth to the lowest reached is 3°·7, which is at the rate of 1° F. for 68 feet.

The elevation of Manegaon is estimated at 1,400 feet. It lies "in an open valley of the Satpuras, traversed by the Dudhi River, south of the wide plains of the Narbada Valley, about halfway between Jabalpur and Hoshungabad, which are 150 miles apart." Jabalpur is 1,351 feet above sea-level, and has a mean annual temperature of 75°·2. Hoshungabad is 1,020 feet above sea-level, and has a mean annual temperature of 78°·3.

"The geological conditions of the position are favourable for these observations. The rocks consist of steady alternations, in about equal proportions, of fine softish sandstones, and hard silty clays of the upper Gondwana strata, having a steady dip of about 10°. . . Strong trap dykes are frequent in many parts of the stratigraphical basin; but there are none within a considerable distance of these borings. There are no faults near, nor any rock-features having a known disturbing effect upon the heat-distribution."

Mention was made in last report (p. 209) of two methods which had been suggested by members of the Committee for plugging

bores to prevent the convection of heat. Mr. Lebour, at the request of the Committee, has conducted experiments during the past year on both forms of plug. He reports that :—

"In accordance with Sir W. Thomson's suggestion, discs of india-rubber fixed to the lowering wire above and below the thermometer have been tried. The chief difficulty met with was the unwieldiness of the armed portion of the wire, which could not be wound and unwound from the drum, owing to the fixed disc-holders. This difficulty prevented the placing of the discs anywhere but at the extremity of the wire, whereas it would be very desirable to have a large number of them at intervals along the greater part of its entire length. Discs for a 2½-inch bore were found to work well with a diameter of 2¼ inches. The lowering, and especially the raising, of the wire armed with the disc-plugging were very slow operations, owing to the resistance opposed by the water to the passage of the discs.

Experiments with the form of plug devised by Mr. Lebour himself were continued with a set of better made plugs. "The great disadvantage of this system of plugging is the necessity for using two wires, one to lower the thermometer and plug as usual, and the other to let down weights upon the upper ends of the plugs, when they are to be expanded, and to remove them when they are to be collapsed. This necessitates not only the ordinary drum for the first wire, but also an independent reel for the second. With care, however, and after some practice, the apparatus was found to work well; but it certainly is extremely inconvenient for rapid work, as it requires a good deal of setting up."

Experiments were made with both forms of plug at the depth of 360 feet, in a bore of the total depth of 420 feet. In the one case, eight india-rubber discs were employed, four above and four below the thermometer; in the other, two collapsible plugs, one above and the other below. The experiments had chiefly in view the mechanical difficulties of the subject, and are not decisive as to the sufficiency of the plugs to prevent convection.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

PROPOSED NEW UNIVERSITY.—A movement has for some time been on foot for the establishment of a new university in the north of England, and on Tuesday last week a deputation, which included the Rev. Dr. Gott (Vicar of Leeds), Mr. Edward Baines, Prof. Thorpe, Prof. Rücker, and Mr. R. Reynolds, waited upon the Mayor of Bradford, Mr. B. Priestly, with the object of inducing the Corporation of Bradford to adopt a memorial to the Privy Council in favour of the proposal. The Mayor intimated that the matter would be referred to the Finance and General Purposes Committee of the Corporation for consideration.

FRANCE.—A commission of twenty-two members has been appointed by the Chamber of Deputies of the French Republic, to prepare a general law on primary instruction.

Two new professorships of botany have been created in the faculties of Lille and Rennes.

PARIS.—The medical course at the University is attended at present by 23 ladies, including 12 Russians, 6 English, and 5 French. Since 1865, 30 ladies have studied medicine at Paris, 9 of whom have received the doctor's diploma.

HIGHER FEMALE EDUCATION.—The subject of the admission of female students to the universities is exciting at present an unusual degree of discussion in Germany as well as in England. In this connection we notice the publication of a letter from Prof. G. H. Meyer, of the medical faculty of Zurich, in which he states, as the result of the experience of a number of years with female students, that he can detect no difference in the average amount of talent and application shown by the representatives of the two sexes under his charge. From a social as well as a professional standpoint, the advanced position taken by the University of Zürich in this direction, during the past few years, is shown to be justified.

KÖNIGSBERG.—The university is attended at present by 655 students, including 42 in the theological faculty, 174 in the legal, 134 in the medical, and 305 in the philosophical. But 42 are from outside of Prussia. The corps of instructors numbers 40. The university possesses a library of 155,000 volumes, an observatory, the zoological museum founded by von Baer, and numerous clinics. On February 2 the eminent philosopher, Herr Rosenkranz, celebrated the fiftieth anniversary of his receiving his doctor-diploma. The German Emperor, the Crown Prince, and all the German Universities, sent congratulatory telegrams and addresses.

HALLE.—On February 27 the 150th anniversary of the establishment of an agricultural chair was celebrated at the Halle University. At the same time the fifteenth anniversary of the opening of the Halle Agricultural Institute, under the direction of its founder, Prof. Kühn, was solemnised. A torchlight procession and banquet were followed by the laying of the foundation-stone for a new geological museum, which is principally destined to contain a geognostical collection of the most important formations in their natural form and succession.

MUNICH.—The rapid increase in the attendance shows that this young University is taking a leading position in Germany. At present the students number 1,360, an increase of over 200 on 1876–77. The philosophical faculty contains 400, and the medical 340. Countries outside of Bavaria are represented by 346. The corps of instructors number 114.

GIESSEN.—The university is attended at present by 315 students, of whom 237 are natives of Hesse. There are but 16 students of chemistry, a striking contrast to the numbers which were wont to flock from all quarters to Liebig's laboratory.

MARBURG.—The number of students in attendance on the university during the past winter was 415. They were divided among the faculties as follows: —Theology 51, law 85, medicine 100, philosophy 179. The Prussian students numbered 263.

BONN.—The professorship of geology and palæontology in this university has been offered to the well-known geologist, Prof. von Seebach, of Göttingen.

KIEL.—The vacant chair of botany is to be filled by Prof. A. Engler, of Munich.

DRESDEN.—A congress of representatives from all the German technical institutions is to take place at Dresden shortly after Easter.

LEIPZIG.—A young lady has taken here, for the first time, the degree of Doctor of Jurisprudence in the legal faculty.

PRUSSIA.—The number of legal students in the various universities has increased so rapidly of late years that they now form three-tenths of the total number.

GERMANY.—From statistical results published by the *Neue Deutsche Schul Zeitung*, it is shown that 60,000 schools with 6,000,000 pupils are in existence in Germany, for a population of about 40,000,000 inhabitants.

MADRID.—The Royal School of Mines has recently celebrated its 100th anniversary and published a handsome historical work in commemoration of the event.

UPSALA.—The University is attended at present by 1,370 students, consisting of 331 in the theological faculty, 145 in the legal, 181 in the medical, and 713 in the philosophical. The corps of instructors numbers 110, including 30 ordinary and 9 extraordinary professors.

SCIENTIFIC SERIALS

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xi., fasc. i. and ii.—On some propositions of Clausius on the theory of potentials, by M. Beltrami.—On the composition of cheeses, and on the emanation of fat from their albuminoid substances during maturation, by MM. Musso and Menozzi.—On determination of the nitrogen in milk and its products, by M. Menozzi.—On the resistance of the helices of telegraphic electro-magnets, by M. Ferrini.—Experimental researches on heterogenesis; on the limit of productivity of organic solutions (third communication), by MM. Maggi and Giovanni.—Chemical manures, the agrarian industry, and funded property, by M. Gaetano.—On a reaction of substances reductive in general, and in particular of glucose, by M. Pollacci.—On granite in the serpentine formation of the Apennines, by M. Torquato.

Morphologisches Jahrbuch, vol. iv. part 1, commences with a paper of 111 pages by Max Fürbringer on the comparative anatomy and development of the excretory organs of vertebrata. Nearly fifty figures are given to illustrate the early stages of these organs in the common frog and salamander, a full *résumé* is given of all observations on those of other vertebrates; together with a discussion on their homologies, and on their indications of relationship to the segmental organs of worms.—A careful description of the anatomy of *Isis neapolitana*, n. sp., is given by

G. von Koch.—Dr. H. von Ihering's contribution to the anatomy of Chiton deals chiefly with the sexual apparatus, the kidney, and the muscles. He show that in Chitonidæ the sexes are undoubtedly separate, and that the ova are fertilised in the ovary.—Observations on the formation, fertilisation, and segmentation of the animal egg, by Oscar Hertwig, part 3, 20 pages, 3 plates. This part deals with the ova of the star-fish, Asteracanthion.

Zeitschrift für wissenschaftliche Zoologie, vol. xxx. part 2.—Contribution to the knowledge of the flagellate infusorians and some related organisms, by O. Bütschli, 78 pp. 5 plates, describing or criticising a great number of species.—On the lungs of *Birgus latro* (land crab), by C. Semper.—The copulatory organs of plagiostomes, by K. R. Petri, 48 pp. 3 plates.—The central nervous system of the alligator, by Rabl-Rückard, 38 pp. 2 plates.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 28.—"Measurements of Electrical Constants. No. II. On the Specific Inductive Capacities of Certain Dielectrics," by J. E. H. Gordon, B.A. Camb. First Series. Communicated by Prof. J. Clerk Maxwell, F.R.S. (Abstract.)

The author has, under Prof. Clerk Maxwell's directions, carried out some measurements of specific inductive capacities by a new method.

The author finds that all his results are much lower than those obtained by previous experimenters, and suggests that the fact may perhaps be explained on a supposition that the specific inductive capacity of dielectrics increases from an inferior to a superior limit during the first small fraction of a second after the commencement of the electrification. He discusses this question at some length in his paper.

"On the Thermo-Electric Properties of Liquids," by G. Gore, LL.D., F R.S.

In this communication the author has described an improved apparatus for examining the thermo-electric properties of liquids, by the use of which, with the precautions stated, all sources of error in such experiments appear to be removed; he has also described a number of experiments he has made with it, and the results obtained.

By employing a sufficient number and variety of electrically-conducting solutions, of acids, salts, and alkalies, in those experiments, he has discovered several exceptions to the usual effect he had formerly obtained, viz., that acid liquids are thermo-electro-positive, and alkaline ones thermo-electro-negative, and has sketched a diagram representing the thermo-electric behaviour of heated platinum in three of the exceptional liquids.

Reasoning upon the satisfactory results obtained, he concludes:—(1) That the electric currents are not produced by chemical action; (2) Nor by a temporary disassociation of the constituents of the liquid; (3) Nor by the action of gases occluded in the metals; (4) But that they are produced purely and solely by the heat, and that heat disappears in producing them; (5) That they are immediate or direct effects of the heat, and that aqueous conducting liquids, therefore, possess true thermo-electric properties; (6) That the current is a result of a difference of thermic action at the surfaces of the two pieces of metal; (7) That it is a product of a suitable molecular structure of the liquid, a change of such structure resulting from alteration of temperature, and a direct conversion of heat into electricity; and (8) That the circumstance which is most influential in enabling heat to produce the currents, and most determines their direction and amount, is a suitable molecular structure of the *liquid*.

By means of the apparatus and process described, he has discovered irregular molecular changes in several of the liquids examined; and as molecular changes are the bases of various physical and chemical alterations, he suggests the use of this apparatus and method as a new one for discovering anomalous molecular alterations, and other coincident physical and chemical ones, in electrically conducting liquids; and for detecting differences of electric potential between metals and liquids at different temperatures.

By reasoning upon the different results obtained, he concludes also as probable, that when a piece of metal is simply immersed in a suitable liquid, a change of temperature occurs; and this (if correct [1]) is a parallel fact to that of the production of electricity by simple contact only. The results also support the contact theory of voltaic electricity.

The paper concludes with several suggestions of new lines of research suggested by the experiments, one of which is the construct on of a new thermo-electro-motor.

Chemical Society, March 30.—Anniversary meeting.—Dr. Gladstone, president, in the chair.—The following is a brief summary of the president's address:—The bye-laws have been thoroughly revised. Successful efforts have been made to expedite the publication of the *Journal*, and a sub-editor, Mr. C. E. Groves, has been appointed. The Research Fund now amounts to 4,000*l.*, and already two papers have resulted from the assistance rendered by it to investigators. The President hopes that many chemists, especially those to whom the pursuit of chemistry has become a source of wealth, will contribute to this important fund. During the past year an independent body, the Institute of Chemistry of Great Britain and Ireland has been formed and incorporated; its objects, which are quite distinct from those of the Chemical Society, are the encouragement of the study of chemistry and the maintenance of the profession on a sound and satisfactory basis. Sixty-five papers have been read during the past session, and two lectures have been delivered. There are at present 965 Fellows. The Society has lost by death one eminent foreign member, M. Regnault, and, besides, Messrs. R. Apjohn, J. J. Griffin, W. Gossage, T. Hall, E. L. Koch, M. Murphy, Dr. Noad, and E. F. Teschemacher. After several votes of thanks, &c., the following officers were elected for the ensuing year:—President—J. H. Gladstone, Ph.D., F.R.S. Vice-presidents—F. A. Abel, C.B., Sir B. C. Brodie, W. De la Rue, E. Frankland, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, T. Andrews, W. Crookes, F. Field, N. S. Maskelyne, H. E. Roscoe, R. Angus Smith. Secretaries—W. H. Perkin and H. E. Armstrong. Foreign Secretary—Hugo Müller. Treasurer—W. J. Russell. Council—Lothian Bell, M. Carteighe, A. H. Church, W. N. Hartley, C. W. Heaton, D. Howard, G. Matthey, E. Riley, W. A. Tilden, R. V. Tuson, R. Warington, C. R. A. Wright. During the meeting it was announced that Mr. Warren De la Rue had presented the Research Fund with the sum of 100*l.* on the condition that it should be devoted to any one important research.

Anthropological Institute, March 12.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—Prof. A. Graham Bell read a paper on the natural language of the deaf and dumb. The author stated that in most cases dumbness was merely a consequence of deafness, and does not arise from any deficiency in the vocal organs, but merely from the inability to acquire articulate language, from want of means of imitating it. This can be supplied by teaching. The dogma, "without speech, no reason," is not well founded. Deaf-mute children think in pictures. Thence they form a language of signs which, as contractions of it become understood, develops into a conventional language, but its extent is very limited. No deaf-mute has been found who had formed the idea of a Supreme Being. About the commencement of the present century the Abbé de l'Epée opened an institution for the education of deaf-mutes. The tendency of education was to render the language more and more conventional by means of contractions. Of this Mr. Bell gave many interesting examples. The result of systematic education has been to enable the deaf-mutes to form a community among themselves, using a real language, representing abstract ideas as well as mere objects. Not only so, but the language has idioms of its own; for example, the objective case comes first—thus, "the boots made the bootmaker." This is a difficulty, and perhaps a mistake in the education; it affords, however, a useful subject for anthropological inquiry into the analogy with the development of spoken language. In illustration, Mr. Bell delivered the Lord's Prayer in the sign language. The North American Indians have a sign language, the same in character, but less developed, than that of the deaf-mutes. The language of the deaf-mutes is beginning to split into dialects.

Photographic Society, March 12.—J. Glaisher, F.R.S., president, in the chair.—Papers were read by Dr. van Monckhoven on the fading of carbon prints, and the suppression of

[1] Since writing the paper he has proved, by experiment, that when a shee t of platinum is immersed in various saline, alkaline, and acid liquids, a slight rise of temperature takes place; the solutions already employed, in which such a result occurs, are enumerated.

bichromates in carbon printing, and by Edwin Cocking, on non-converging perpendiculars in architectural photographs. Dr. Monckhoven, in his paper, asserts that neither hot water nor alum fix carbon prints, and although excess of bichromate of potash is removed, still the chromic salt, which has rendered the gelatine insoluble, not only remains, but undergoes a change by subsequent exposure to light, and thus accelerates the action of light upon the organic colour of the pigment, which fades rapidly. He suggests a new fixing agent, bisulphite of soda, and for colour some of the oxides of iron, mixed when moist, with glycerine and gelatine, which he states are absolutely unalterable by exposure to light.

EDINBURGH

Royal Society, March 8.—Sir William Thomson in the chair.—Prof. Tait read a paper on thermal conductivity, the result of experiments during the last ten years. His results for iron are much the same as those obtained by Principal Forbes. He had solved the following problems:—1. That, with the exception of iron, in no case as yet tried does a pure metal diminish in thermal conductivity as the temperature rises. 2. That different specimens of the same metal, as, for instance, two kinds of copper differ much the same relatively in thermal and in electric conductivity. 3. A substance which is pretty constant as a conductor of electricity is also pretty constant in thermal conductivity. Among the difficulties encountered was the alteration of the zero point of the thermometers used—Kew standards—after being heated to a high temperature. This affects only the absolute values slightly, but not the general character of the results. Another difficulty was the oxidation, during heating, of the short bars employed to measure the heat lost by radiation and convection at different temperatures. This was almost completely overcome.—Prof. Fleeming Jenkin and Mr. J. A. Ewing communicated a paper on the wave forms of articulate sounds obtained by the aid of the phonograph. Their results show that Helmholtz's theory of vowel sounds, viz., that for the production of any one vowel certain fixed notes are necessary, is not tenable, as they obtained vowel sounds under circumstances which rendered the presence of some of these notes impossible. They have also made out that every vowel and every consonant is reversible. This is true also of such single sounds as *ng*, *th*, *ch*, &c. A number of curves were exhibited showing the form of the indentations on tinfoil produced by various articulate sounds, multiplied about 400 times by means of a system of levers.—A paper by Mr. George M'Gowan on the action of the chlorides of iodine on acetylene and ethylene, was read by Mr. J. Y. Buchanan.

PARIS

Academy of Sciences, April 1.—M. Fizeau in the chair.—The following papers were read:—On some applications of elliptic functions (continued), by M. Hermite.—Parameters of elasticity of solids, and their experimental determination, by M. de Saint-Venant.—On the specific heats and the heat of fusion of gallium, by M. Berthelot. The liquid specific heat was found to be 0·0802; the solid, 0·079. Referred to 69·9 as the atomic weight, the heat of fusion was 1·33 cal. As with mercury, lead, tin, and bismuth, the solid and liquid specific heats, taken at the same temperature, are closely alike. The specific atomic heat of gallium (liquid 5·59, solid 5·52) is about the same as that of aluminium (5·53) and that of glucinium (5·64).—Action of oxygen on acid chlorides, bromides, and iodides; compounds of aluminium, by M. Berthelot.—On the movements of storms, by M. Faye.—On the whirlpools of watercourses, by M. Belgrand. He notices some phenomena of streams as illustrating M. Faye's theory.—Observations on the nature of the plants collected in the group of *Næggerathia*; types of *N. flabellata*, Lindl. and Hutt., and *N. cyclopteroides*, Gœpp., by M. de Saporta.—The conidia of *Polyporus sulfureus*, Bull, and their development, by M. de Seynes.—Action of the sun on the magnetic and electric fluids of the earth, by M. Quet. The subject is treated mathematically.—On the linear differential equation which connects with the modulus the complete function of the first species, by M. Tannery.—On the kinematics of continuous figures on curved surfaces, and, in general, in plane or curved varieties, by M. Levy.—Actinometric measurements made in Algeria during the summer of 1877, by M. Violle. These were partly made in the dry Saharan climate of Laghouat, 466 kilom. south of Algiers, partly at Fagrait, a height of 993 m., and at Khanza, 740 m. ower. The method was the same as M. Violle used on the top of Mont Blanc two years ago. The numbers obtained for the solar constant in the former case, by Pouillet's and Forbes' formulæ, were 2·40 and 2·42; both less than 2·54, the value got on the top of Mont Blanc. The ratio of the intensities of solar radiation in the plain and on the mountain was 0·915.—On astronomical refraction, by M. Makarevitsch.—On the physical properties and the specific heat of glucinium, by MM. Nilson and Pettersson. They obtained large quantities of crystalline glucinium by heating to a red heat a cylindrical mass of iron, containing, in a hole closed with a screw, some of the chloride and some sodium freed from its oil of naphtha. The compound of marine salt and glucinium found after cooling, is washed with water, and the reduced metal (impure) appears in bright spangles, or dendrites, or small globules. The density of pure glucinium is calculated to be 1·64; specific heat 0·4084. The atomic weight Be = 13·8, and the formula for the oxide Be_2O_3 (assigned by Berzelius) a confirmed.—On a reaction peculiar to some polyatomic alcohols, by M. Klein. It is shown that all the ethers of mannite and its derivatives possess rotatory power.—On a new method of separation of arsenic from other metals, by MM. De Clermont and Frommel. This is based on the fact that while a large number of hydrates of sulphides are dissociated at 100° into sulphuretted hydrogen and oxide, sulphide of arsenic is the only one which gives a soluble oxide, arsenious acid. Hence, if a mixture of sulphide of arsenic and other sulphides be brought to boiling, the sulphides will all be oxidised, and remain insoluble in the water, except arsenious acid, which may then be easily isolated.—On melilotol, by Mr. Phipson. This is a new oily product got by distilling with water, dried *Melilotus officinalis*, then treating the distilled water with ether which dissolves the substance, so that it is got very pure after evaporation. To it is due the odour of melilot and hay.—Telephone employed as galvanoscope, by M. D'Arsonval. The worst constructed instrument is found to be at least 100 times more sensitive than the nerve for revealing weak electric tensions. It is very well adapted for studying the electric tetanus of muscle.—On anthrax in the horse and the dog; phlogogenic action of anthracic blood, by M. Toussaint. The phlogogenic matter accompanying the bacterides is more or less active according to the source whence these latter come.—On the epoch of formation of the cloaca in the embryo of the common fowl, by M. Cadiat.

GÖTTINGEN

Royal Society of Sciences, January 5.—On a class of differential equations which are integrable by Abel's or elliptic functions, by M. Fuchs.—On the affinities and systematic significance of *Ceroxylon andicola*, by M. Drude.—Some words on the origin of language, by M. Benfey.

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